Comparative study of Papaya Vs Normal Saline Dressing in healing of Ulcers

Dissertation submitted

To

THE TAMILNADU DR. M.G.R. MEDICAL

UNIVERSITY, CHENNAI

In partial fulfillment of the regulations for the award of the degree of

M.S (General Surgery)

Branch-I

Government Kilpauk Medical College

Chennai: April-2015

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled "**COMPARATIVE STUDY OF PAPAYA VS NORMAL SALINE DRESSING IN HEALING OF ULCERS"** is a bonafide and genuine research work carried out by me under the guidance of Prof. Dr. USHA DORAIRAJAN MS, FRCS, Department of General Surgery, Kilpauk Medical College, Chennai-10.

This dissertation is submitted to **THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI** in partial fulfillment of the degree of M.S. General Surgery examination to be held in **April 2015**.

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CERTIFICATE

This is to certify that this dissertation is the bonafide work of

DR B. VIMALAKARAN

On

"COMPARATIVE STUDY OF PAPAYA Vs NORMAL SALINE DRESSING IN HEALING OF ULCERS''

During his course in M.S. General Surgery from May 2012 to April 2015 at Government Kilpauk Medical College, Chennai-10.

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ACKNOWLEDGEMENT

I avail this opportunity to express my profound earnest gratitude to my esteemed teacher and guide Prof.Dr.Usha Dorairajan, M.S,FRCS., Professor of General Surgery, Kilpauk Medical College and Hospital for her unflinching support, valuable guidance and encouragement provided to me during this study, without which it would not have been possible for me to complete this work.

I express my sincere thanks and gratitude to my esteemed teacher Prof.Dr.P.N.Shanmugasundaram, M.S., Head of Department of General Surgery, Kilpauk Medical College and Hospital for his expert guidance and immense support during the course of this study.

I would like to thank my teachers Dr.V.Vijayalakshmi, M.S., Dr.N.B.Thanmaran, M.S., Dr.A.K.Kalpanadevi, M.S., Dr.K.Ramachandran, M.S., for their continuous support and encouragement.

It is with immense honour and pleasure that I take this opportunity to thank our Dean, Prof.N.Gunasekaran M.D, D.T.C.D., for his support, encouragement and facilities provided during the course of this dissertation.

I am grateful to all my patients for their cooperation without which this study would not have been possible. I am deeply indebted to the Government of Tamilnadu for giving me this opportunity.

(Dr.B.Vimalakaran)

ABSTRACT

AIM:

To compare the effectiveness of papaya and normal saline in healing of ulcers.To evaluate the role of papaya dressing in wound debridement, granulation tissue formation, reduction in ulcer size and ulcer healing.

BACKGROUND:

Wet to dry normal saline mechanical debridement is the most common, cost effective debridement method which is used widely, in our hospital setup also in management of wound care. Papaya has been a enzymatic debriding agent which is in use for many years. There has been various review articles and studies on the debriding properties of papaya in western population and diabetic rats.This study was conducted to compare the efficacy of two debriding agents : enzymatic debridement with papaya and wet to dry normal saline mechanical debridement on diabetic wounds, sloughed infected wounds and in post operative wound dehiscence.

MATERIALS AND METHODS:

This is a comparative interventional study of 100 patients done at Government Kilpauk Medical College Hospital Chennai between August 2013 to August 2014.patients were selected and randomized into two groups Group I – treated with papaya and Group II with normal saline. Patients were clinically assessed at the time of inclusion and daily dressing was done. Patients were assessed weekly for 4 weeks and response noted regarding slough reduction, granulation tissue formation, reduction in ulcer size and overall response to treatment. Additional treatment and follow up upto 3 months were recorded.

RESULTS:

Papaya is a better and efficacious debriding agent in comparison to wet to dry normal saline dressing and it also promotes faster granulation tissue formation. Overall response to treatment with papaya is good.

COMPARATIVE STUDY

OF

PAPAYA Vs NORMAL SALINE

DRESSING IN HEALING OF

ULCERS

TABLE OF CONTENTS

Introduction

INTRODUCTION

Wound management has been a fundamental part of general surgical practice since ancient times. Chronic non-healing wounds pose a remarkable challenge to health professionals and drain our resources. In recent years, prevalence of diabetic foot ulcers is growing at epidemic proportion in India and worldwide and they have become the major contributors of chronic non-healing wounds.

Although wound management is a day-to-day activity in surgical wards, there is always scope for betterment of our surgical practice. Therapeutic strategies have been evolving over the years and there are varieties of dressing options available for wound bed preparation, wound cover, activation of wound healing and repair. Technological advancements have also resulted in topical applications of recombinant platelet derived growth factors and bio engineered skin substitutes for skin coverage in wound management.

The sequence of wound repair is controlled in each stage by activators and inhibitors that are naturally produced by our immune system. Cellular migration, proliferation, matrix deposition and remodeling which causes progress in wound healing.[1] . Devitalized tissue and exudates act as mechanical barrier to migration of cells and provides an environment ideal for bacterial proliferation [2]. Due to the presence of devitalized tissue there is excess production of pro-inflammatory cytokines and prolongation of inflammatory response [3].

Thus wound bed preparation plays a crucial role in achieving a conducive environment for wound healing. There are various modalities available for wound debridement; most of these methods are covered in this review with major emphasis on enzymatic wound debridement with papaya. In my study, I have compared two debridement methods, one which we use regularly in our hospital, wet to dry normal saline dressing and enzymatic debridement with papaya.

Aim

AIM

To compare the effectiveness of papaya versus normal saline debridement in healing of ulcers.

To evaluate the role of papaya dressing in wound debridement, granulation tissue formation, reduction in ulcer size and ulcer healing.

Review of Literature

HISTORY

- History of wound management dates back to 2200 B.C. (circa) in an ancient clay tablet which describes “Three healing gestures”
    1. Washing the wound
    2. Plaster making
    3. Wound bandage
- In 2000 B.C., the Sumerians employed spiritual and physical methods in wound healing
- In 1650 B.C., Ebers Papyrus describes use of concoctions containing honey, lint and grease in wound management [(4)].
- In 1867 AD., Lister introduced the first antiseptic dressing using lint and gauze soaked in carbolic acid which impressed Robert Wood Johnson who improvised antiseptic dressing with cotton gauze impregnated with iodoform.
- Earliest non adherent dressing which gained popularity in World War-I was gauze impregnated with paraffin tulle[(5)].

In recent times many sophisticated and technically advanced dressing materials are available for wound care management.

DESIRABLE DRESSING MATERIAL

Dressing should ideally protect the wounds from trauma, foreign bodies and bacterial contamination, should absorb the wound exudates, give good compression, reduce the dead space and minimize wound edema.

- Dressing should provide a moist, warm occlusive environment to maximize epithelialization and reduce pain.
- Importantly it should prevent heat and fluid loss from wounds especially with large surface area, e.g., burns
- Non-adherent dressing is generally desirable as it limits wound disruption during change of dressings.

Regardless of dressing materials all dressings should be aesthetically acceptable. But no single dressing has all these properties and also all wounds do not require all these functional properties [6].

The concept of occlusive dressing has created a paradigm shift in wound management. In occlusive dressings there is two fold increase in rate of epithelialization when compared to wounds which were kept open and dry [7]. Occluded moist environment provides a mildly acidic pH and low oxygen tension on wound surface. This low oxygen tension stimulates fibroblast proliferation and

granulation tissue formation [8, 9]. Moisture in occlusive dressing facilitates angiogenesis and epidermal migration[10]. Moisture also prevents desiccation and supports autolysis of necrotic material[11].

Major disadvantage of placing an occlusive dressing is, it encourages bacterial proliferation and spread of infection in infected wounds. Wounds containing nonviable tissues and large exudative wounds that require high degree of absorption, occlusive dressing have no role. In these situations, dressing regimens containing antimicrobial activity and regimens that contribute to wound debridement are necessary.

WOUND HEALING - PATHOPHYSIOLOGY

Wound healing or repair is an effort of the injured tissue to restitute its normal function and structural integrity after injury which involves a complex cellular and biochemical cascade. Normal wound healing involves three overlapping phases.

1. Hemostasis & Inflammation
2. Proliferation
3. Maturation & Remodeling

INFLAMMATORY PHASE (4 – 6 DAYS)

This phase is characterized by stoppage of bleeding, sealing of wound surface, removing bacteria and necrotic debris. Polymorphonuclear leukocytes appear after 48 hours and release inflammatory mediators and macrophages secrete fibroblastic growth factors. There is increased vascular permeability, migration of cells by chemotaxis, secretion of cytokines and growth factors into the wound. Chemical factors involved are, platelet derived growth factor, epidermal growth factor and transforming growth factor. Cytokines like TNF-α, Interleukin-1 & Interleukin-6. Enzymes like collagenase, elastase and prostaglandin-E2 play a major role in this phase.

PROLIFERATIVE PHASE (7 DAYS – 6 WEEKS)

Characterized by angiogenesis, fibroplasia and formation of granulation tissue. Formation of granulation tissue requires fibroblasts, macrophages, capillary bed, and loose arrangement of fibronectin, collagen and hyaluronic acid.

MATURATION & REMODELING PHASE (6 WEEKS – 2 YEARS)

Maturation phase is a result of complex interaction of extra cellular material and fibroblasts, leading on to wound contraction. Wound contracture reduces the amount of disorganized scar by centripetal movement of the surrounding skin. Matrix metaloprotein-3 appears to be a strong factor in wound contracture, which helps in breakdown of collagen. Wound strength and integrity ultimately depends on balance between collagen deposition and degradation[(12)].

CHRONIC WOUNDS - PATHOPHYSIOLOGY

Chronic wounds are defined as, wounds that fail to proceed in the orderly process of healing and producing an unsatisfactory anatomical functional integrity. Chronicity of wounds is perpetuated by repeated trauma, hypoxia, poor perfusion and excessive inflammation. Unresponsiveness to normal regulatory stimulus of wound healing leading to failure of normal growth factor synthesis[13].

In chronic wounds, it has been found that there is increased break down of growth factors with over expression of proteolytic activity and failure of normal antiprotease inhibitor mechanisms[14] . There is presence of senescent fibroblasts with poor proliferative potential and decreased growth factor receptor expression in chronic wounds[15].

DIABETIC WOUNDS

Diabetic ulcers are the major contributors for chronic non-healing ulcers, which is attributed to neuropathy, foot deformity and ischemia in long standing diabetes. 60% to 70% diabetic ulcers are due to neuropathy and 15% to 20% are due to ischemia while the remaining are due to a combination of both these factors.

Neuropathy in diabetes is both motor and sensory and it is due to persistently elevated glucose levels. Motor neuropathy leads to Charcot's arthropathy, which is characterized by collapse of inter phalangeal or metatarsophalangeal joints causing pressure ulcers in unprotected areas. Sensory loss allows unrecognized injury due to trivial trauma, ill fitting footwear and foreign bodies.

There is severe micro and macro vascular circulatory impairment contributing for local hypoxia. Once ulceration occurs, uncontrolled diabetes results in reduced inflammation, poor angiogenesis and collagen synthesis. There is an increased rate of wound infection and failure in diabetic wounds[16].

There is defective granulocyte function, fibroblast proliferation and capillary ingrowth observed in diabetic wounds. Obesity, hyperglycemia and insulin

resistance individually and significantly contribute to impaired wound healing[17] . Wound healing significantly improves in patients with good glycemic control, inspired oxygen tension, appropriate antibiotics and correction of co-existing metabolic abnormalities[18].

WOUND DEBRIDEMENT: AN OVERVIEW

Henry Le Dran (1685 – 1770) was the first person to coin the term debridement in the context of an incision to promote drainage and relieve tension. It is derived from the French word meaning remove a constraint[19] .

Debridement is defined as the act of removing necrotic material, foreign bodies, slough, puss, infected tissue, hematoma, hyperkeratosis, bone fragments or any other type of bio burden from wound, decrease odour, stimulate epithelialization and the objective is to enhance wound healing and quality of life[20]. Wound debridement is different from wound bed preparation, as debridement takes care of not only the wound bed but also wound edges and periwound skin which are a crucial factor for wound healing[21] .

Modern day surgical practitioners use the TIME acronym to accurately assess the wound, infection, necrotic debris and plan of action.

T - Tissue which is nonviable

I - Infection or Inflammation

M - Moisture Imbalance

E - Edge whether non advancing or undermined[22] .

RATIONALE FOR DEBRIDEMENT

- Reduction in Bacterial Burden
- Removal of Necrotic Debris
- Activation of growth factors
- Senescent cells from wound bed are removed
- Non migratory cells from ulcer edge which hinders wound healing are removed

Microorganisms contribute in a multifactorial way for impaired wound healing. In the presence of necrotic tissue, there is a high grade of bacterial proliferation, colonization of bacteria in wound beds leading to an altered inflammatory response, release of free oxygen radicals and proteolytic enzymes which cause tissue damage[23] . Proteases released by these microorganisms damages the growth factors and impair healing[24] .

Exudate production causes degradation of extracellular matrix proteins and reduction in cellular proliferation[25] . Formations of biofilm due to communities of bacteria cause resistance to antibacterial treatment and tightly adhere to wound bed. Debridement effectively detaches these biofilms from wound bed[26] .

ACTIVATION OF GROWTH FACTORS

Reduced availability of growth factors and deficient factors are seen in chronic wounds[27] . In altered wound healing pathways, growth factors become unavailable due to abnormal binding to matrix protein and necrotic tissue acts as physical barrier to growth factor receptor interaction [28] . Debridement results in fresh bleeding, activation of platelets, release of various growth factors, cytokines and fibronectin which are important essential components of good wound healing[29] .

REMOVAL OF SENESCENT CELLS

Senescent cells remain viable but they have a markedly decreased proliferation rate and poor response to growth factor stimuli. In chronic wounds, senescent fibroblasts have been present for longer duration and delay in wound repair. By debridement removal of these senescent cells is possible and results in production of viable cells in wound bed[30].

In chronic wounds, the wound edges become thickened and contain non migrant hyper proliferative epithelium which hinders wound healing that can be removed by wound debridement[31].

WOUND DEBRIDEMENT METHODS

- Surgical / Sharp Debridement
- Mechanical and Technical solutions
- Autolytic Debridement
- Biological Debridement
- Enzymatic Debridement

SURGICAL & SHARP DEBRIDEMENT

Surgical debridement is defined as procedure done under anaesthesia using a variety of surgical instruments. Sharp debridement is a minor bedside surgical procedure using scissors or scalpel to cut away tissues. Surgical debridement is generally used when rapid and major intervention is required.

Indication for surgical debridement is when, there is a thick solid layer of necrotic tissue with a clear demarcation between viable and nonviable tissue. It is an important life saving procedure in case of severe wound infections[32 & 33].

BENEFITS OF SURGICAL DEBRIDEMENTS

- Used in all types of wounds
- Rapid and effective removal of necrotic tissue from wound and periwound site
- Alternative to any other debridement methods
- When immediate reconstruction is planned or when there is a possibility to close the wound

LIMITATIONS OF SURGICAL DEBRIDEMENTS

- There is always a risk of over excision and scarring
- Damage to deeper structures, adjacent vessels, nerves and tendons
- Special precaution must be taken while treating face, hands and perineum on account of functional and cosmetic outcome [34, 35 & 36].

MECHANICAL DEBRIDEMENT

Mechanical debridement is a non selective physical method using mechanical force for debridement. Commonly used methods are, Wet to dry saline dressings, paraffin tulle and monofilament fibre pad. Technical solutions include whirlpool therapy, jet lavage system, vacuum assisted closure and ultrasound treatment.

Wet to dry saline gauze dressing is the simplest method and most commonly used method which is used in our hospital setup. Normal saline (0.9%) soaked gauze is placed over the wound bed, as it dries top layers of the tissue in wound bed adheres to the dressing and mechanically removed when the dressing is changed. Limitations of wet to dry debridement, causes considerable pain and injury to normal tissue [(37)]. It is time consuming and needs frequent dressing change with increased risk of infection[(38)].

Monofilament fibre pad is a modern mechanical debridement product in which the necrotic debris is bound to the fibre component and there by removed from the wound bed. Fibre pad is wetted and wiped over the surface for 2 to 4

minutes [39 & 40]. Advantages of monofilament fibre pad are rapid action with little to no pain and it does not remove the healthy granulation and epithelial islands[41].

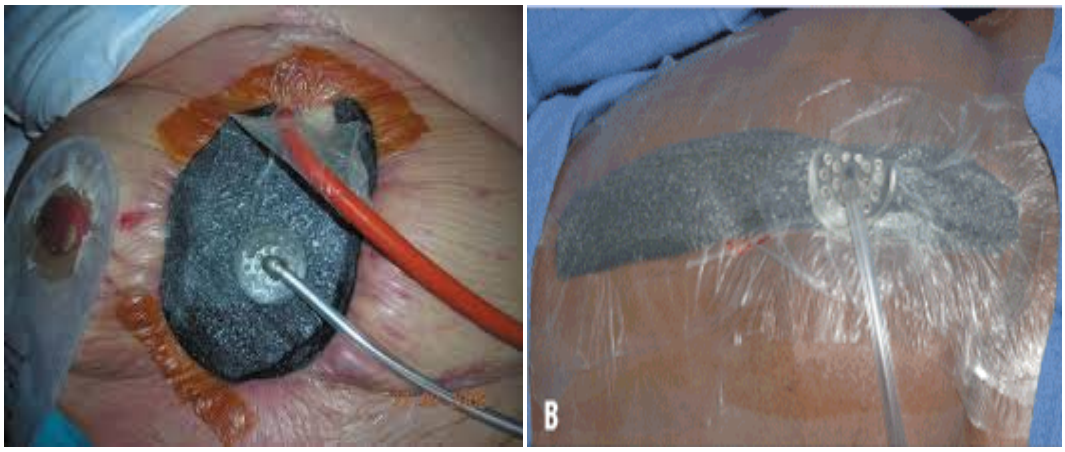
JET LAVAGE / WHIRLPOOL THERAPY:

The principle behind this therapy is, powered irrigation with water which physically removes foreign bodies and loose necrotic tissues from the wound bed. Limitations are cost of these instruments, painful for some patients and may disseminate bacteria[42].

VACUUM ASSISTED NEGATIVE PRESSURE WOUND THERAPY:

It is an indirect debridement technology, removes inflammatory exudates from wound, decrease wound edema, increase blood flow, increase wound contraction and protects the wound from external contamination [43].

Primary limitations, it cannot be used in uncontrolled infections, in presence of necrotic tissue and local ischemia.



LOW FREQUENCY ULTRASOUND:

Mechanism of action depends on the property of ultrasound, particular frequency and intensity of the mechanical energy interferes with structural proteins and cellular bodies and exerting a range of effects that may vary from destruction to dislocation and physical modification. Primarily it is used for debriding purpose and as an adjunct in reparative phase.

Positive features of ultrasound is that, it can be used in different types of tissues, from loose connective tissues to tendons and even bones with high level of effectiveness. It destroys microorganisms and disruption of biofilms.

Limitations of ultrasound – related to difficulty in production of reliable and affordable devices that can be safely applied in wounds with satisfying results [44].

AUTOLYTIC DEBRIDEMENT:

Autolysis is a natural and highly selective process of removing necrotic tissue from wound bed by utilizing proteolytic enzymes in the presence of moisture[45]. They have a dual mode of action in wound therapy as in they donate water to dry wounds and absorb fluids from moderately exudative wounds.

Endogenous proteolytic enzymes like collagenase, elastase, myeloperoxidase, acid hydroxylase are released and activation of phagocytes occurs. These enzymes soften, dissolve and breakdown necrotic or sloughy tissue in the wound, enabling macrophages to digest them. Another aspect of autolytic dressing is, they cause swelling of necrotic tissue and fibrin coatings facilitating their detachment[46].

Hydrogels, hydrofibres, hydrocolloids, multifunctional polymer membrane formation, multicomponent dressings (hydrated alginate polymers – contains autolytic, antimicrobial and absorptive features) and hydration response technology are some of the methods of autolytic debridement in use. Different products are available for varying levels of exudate.

Hydrogels or hydrogel based dressings are cross linked homopolymers with a three dimensional structure, saturated with water.Water content in hydrogel dressings proportionately vary from 30% to 90%.

Hydrocolloids are adhesive compounds that turn into a gel when they come into contact with wound exudate. These compounds are composed of carboxy methyl cellulose, pectin, gelatin and elastomers.For autolytic debridement, a moist wound milieu should be created for optimizing leucocyte and macrophage activity.

INDICATIONS:

- Acute and chronic wounds with necrotic tissue or fibrin coatings
- Soften and liquefy hard eschar and slough
- Dry wounds requiring hydration

BENEFITS OF AUTOLYTIC DEBRIDEMENT:

- Easy to use & cause little to no pain.
- Promote formation of granulation tissue and epithelialization.
- Does not damage healthy granulation tissue.
- Fewer dressing change needed.

DRAWBACK OF AUTOLYTIC DEBRIDEMENT:

- It takes a longer period for wound healing
- Can only be used for infected wounds which are under control
- Contraindication – Contact sensitization to ingredients of the dressings[47].

BIOLOGICAL DEBRIDEMENT:

Live maggots cultured in sterile conditions, usually *Lucilia sericata* (common green bottle fly) is placed on necrotic wounds. Maggots secrete anti-bacterial substances that reduce bacterial load and release trypsin like proteolytic enzymes which cause eschar degradation by digesting the collagen matrix. They promote wound healing and amplify human fibroblast and chondrocyte growth[48].

Larval therapy has been in use for the past 400 years and primarily used when traditional methods are unsuccessful. 24 to 48 hours old sterile larvae (10 to 15 per Sq Cm of wound) applied twice a week and placed for 24 to 72 hours [49].

BENEFITS OF BIOLOGICAL DEBRIDEMENT:

- Reduces pain, bacterial load and malodour.
- Promotes wound healing with little or no side effects.
- Maggot separate necrotic tissue from live tissue allowing for an easier sharp debridement.
- Easy to apply and use of biobags containing larvae are aesthetically acceptable for the patients.

CONTRAINDICATIONS:

- Not to be used in wounds near upper gastrointestinal tract, upper respiratory tract and eyes.
- Patients with allergy for fly larvae are soy-bean protein.
- Not suitable for wounds with exposed blood vessels potentially connecting to vital organs

Only limitation is that the patient should be psychologically prepared to experience maggots' debridement therapy.

There is a re-emergence in the usage of larval therapy due to rise in chronic non healing wounds and emergence of antibiotic resistant bacterial strains in recent years.

ENZYMATIC DEBRIDEMENT

Enzymatic debridement has been in practice for few hundred years in the treatment of sloughed out necrotic wounds. It is a highly selective method of wound debridement which uses proteolytic enzymes that work synergistically with endogenous enzymes and enhance wound repair [50].

MECHANISM OF ACTION:

Proteolytic enzymes hydrolyze peptide bonds and facilitate removal of necrotic tissue from wound bed. These enzymes are divided into endopeptidases and exopepsidases. Endopepsidases digest peptide bonds and exopeptidases hydrolyze amino or carboxy terminals of proteins [51]. Bacterial proteolytic enzymes that are commonly used in enzymatic debridement are collagenase, streptokinase, streptodornase and sutilain. Animal proteolytic enzymes used in debridement are collagenase, catalase, krill multienzyme complex, fibronolysin and deoxyribonuclease .Plant proteolytic enymes are papain from Carica papaya and bromelain enzyme complex from pineapple [52].

PAPAYA IN ENZYMATIC DEBRIDEMENT

The concept of using the latex of papaya fruit for enzymatic debridement relates to the practice of natives in tropical countries who used the latex to treat skin conditions like warts, eczema and ulcers [53]. The very peculiar phenomenon of the fruit is that the scraped part of the fruit healed immediately without any scar marks. The wound healing property of papaya is attributed to the endolytic plant enzyme papain [54].

Latex from raw papaya fruit is rich in papain. Papain has an extensive proteolytic activity, breaks down short chain peptides, amide links and amino acid esters. Papain has a preference to cleave peptide bonds involving basic amino acids and in particular arginine and lysine [55].

PHYTOCHEMICAL COMPONENTS IN PAPAYA

Latex of Carica papaya fruit contains four cysteine endopeptidases namely papain, chymopapain, glycyl endopeptidase and carcain (a papaya endopeptidase-II) [56]. As the fruit ripens papain and chymopapain gets degraded and ripe fruits doesn't contain these two enzymes [57]. Other components include endopeptidase-

IV, omegaendopeptidase, class-II and class-III chitinase and a serine protease inhibitor [58 & 59].

CHEMICAL STRUCTURE OF PAPAIN:

Papain is a globular protein with molecular weight of 23406 DA. Contains 212 amino acids with disulphide bridges and catalytically important glycine-19, cystiene-25, histidine-158 and159 residues [60]. Optimum pH for activity of papain is 3.0 to 9.0 [61]. Papain is usually defiant to high concentrations of denaturing agents and it is very stable even at high temperatures [62]. Papain is stabilized by three disulphide bridges and its three dimensional structures contain two distinct structural domains with an active catalytic diad in the cleft between the domains similar to the structure of chymotrypsin.

MECHANISM OF ACTION OF PAPAIN:

Proteolytic action involves cleavage of polypeptide chains and hydrolysis of collagen cross linkages. It doesn't act on normal tissue as it acts only on tissues lacking α-1 antitrypsin plasmatic antiprotease that inhibits proteolysis in healthy tissues [63].

Cysteine-25 portion is the active site that attacks the carbonyl carbon in the peptide chain, releasing the amino terminal portion. This feature occurs throughout the peptide chain resulting in the breakdown of protein. Deprotonation of cysteine-25 by histidine-159 and aspargine-175 assists to align the imidazole ring of histidine-159 to allow this deprotonation to occur. The unique proteolytic function of papain lies in the coordinated action of this three aminoacids in the active site[55].

WOUND HEALING PROPERTY OF PAPAYA:

Enzymes mainly papain and chymopapain have fibrinolytic activity and assist in removal of slough and necrotic tissue from wound bed. Papaya induces development of healthy granulation tissue, as the fruit is rich in vitamin C which helps in conversion of proline to hydroxyproline which is a specific indicator of collagen content laid during wound healing [64].

It has a potent bactericidal action attributed to an aglycone benzyl isothiocyanate and glycoside-glucotropaelin. These agents have been proven to be active against Bacillus cereus, E.coli, Shigella flexneri, Staphylococcus aureus, and

Pseudomonas. This antibacterial action has been attributed for its healing potential in paediatric burns wound.

Papaya extract breaks down the biofilm defenses, as this biofilm gives protection to bacteria from ultraviolet rays and oxygenation .Bacteria in chronic wounds live within these biofilm communities protecting them from host immune response [65].

Commercial preparations of papain in combination with other chemical agents have been in use. Most commonly used preparation is papain urea (debridase). This combination is used, as urea increases the proteolytic action of papain by reducing disulphide bridges and making the protein more susceptible for its action. Other preparation in the market is papain urea chlorophylline copper complex which acts by inhibiting hemaglutination, inflammatory properties of protein degradation and decreases pain and wound odour [66].

OTHER MEDICINAL PROPERTIES OF CARICA PAPAYA PLANT:

Papaya leaves, seeds, latex and fruit have been proved to have medicinal value due to a wide range of unique properties including anti-inflammatory, free radical scavenging, anti-oxidant, antiviral, anti-diabetic and anti-hypertensive properties [(67)].

Materials & Methods

MATERIALS & METHODS

This is a randomized, comparative interventional study carried out in Kilpauk Medical College Hospital from August' 2013 to August' 2014. The study was approved by the Institution ethical committee. The study group comprised of hundred patients with ulcers due to diabetes mellitus, wound infections and post operative wound dehiscence.

Patients were selected, randomized and divided into two groups.

- Group-1: 50 patients treated with papaya dressing
- Group-2: 50 patients treated with wet to dry normal saline dressing.

METHOD OF DATA COLLECTION:

- Clinical assessment done during time of inclusion
- Complete history and detailed examination done at inclusion
- Ulcer and devitalized tissue accurately assessed
- Measurement of ulcer using sterile gauze and graph paper
- Area of ulcer calculated in Sq.Cm

INCLUSION CRITERIA:

- Patients aged more than 20 years with diabetic ulcers and infected ulcers.
- Wagners ulcer grade-II and grade-III
- Post operative wound dehiscence

WAGNERS ULCER GRADE

- Grade-I: Superficial ulcers
- Grade-II: Deep ulcers upto subcutaneous tissue exposing soft tissue or bone
- Grade-III: Abscess formation underneath / osteomyelitis.
- Grade-IV: Gangrene of part of tissue / limb / foot.

EXCLUSION CRITERIA:

- Ulcers with severe active infections
- Wagners ulcer grade more than III
- X-Ray features of underlying osteomyelitis
- Diabetic foot with major vascular disease
- Uncontrolled diabetes mellitus

- Patients with hepatic, renal and hematological diseases which impair wound healing
- Patients on immunosuppressive drugs, long term steroid therapy, radio therapy or chemotherapy.

INVESTIGATIONS:

- Complete blood count
- FBS and PPBS
- Renal function test
- Liver function test
- Wound culture and sensitivity
- X-Ray of involved part
- Duplex scan, if vascular compromise is suspected

TREATMENT PHASE:

- Patients were randomized using computer generated random table after stabilization of ulcer.
- All patients during initial treatment phase underwent surgical debridement and devitalised tissue was removed.
- Daily cleaning and dressing done till ulcer became stable (i.e., no progression in size of ulcer)
- Good glycemic control was achieved in diabetic patients and maintained throughout the treatment phase.
- Culture and sensitivity was done during the phase and appropriate antibiotics were started.
- Patients were assessed at 0(randomization), 1, 2, 3, 4 weeks and reviewed after three months.
- Reduction in slough, reduction in ulcer size and progression in healthy granulation tissue formation noted weekly.
- Induration, discharge and odour were noted weekly during this phase.
- Safety and tolerability of the study was closely monitored and assessed by questioning the patients regarding pain, itching and hypersensitivity reaction during the treatment phase.

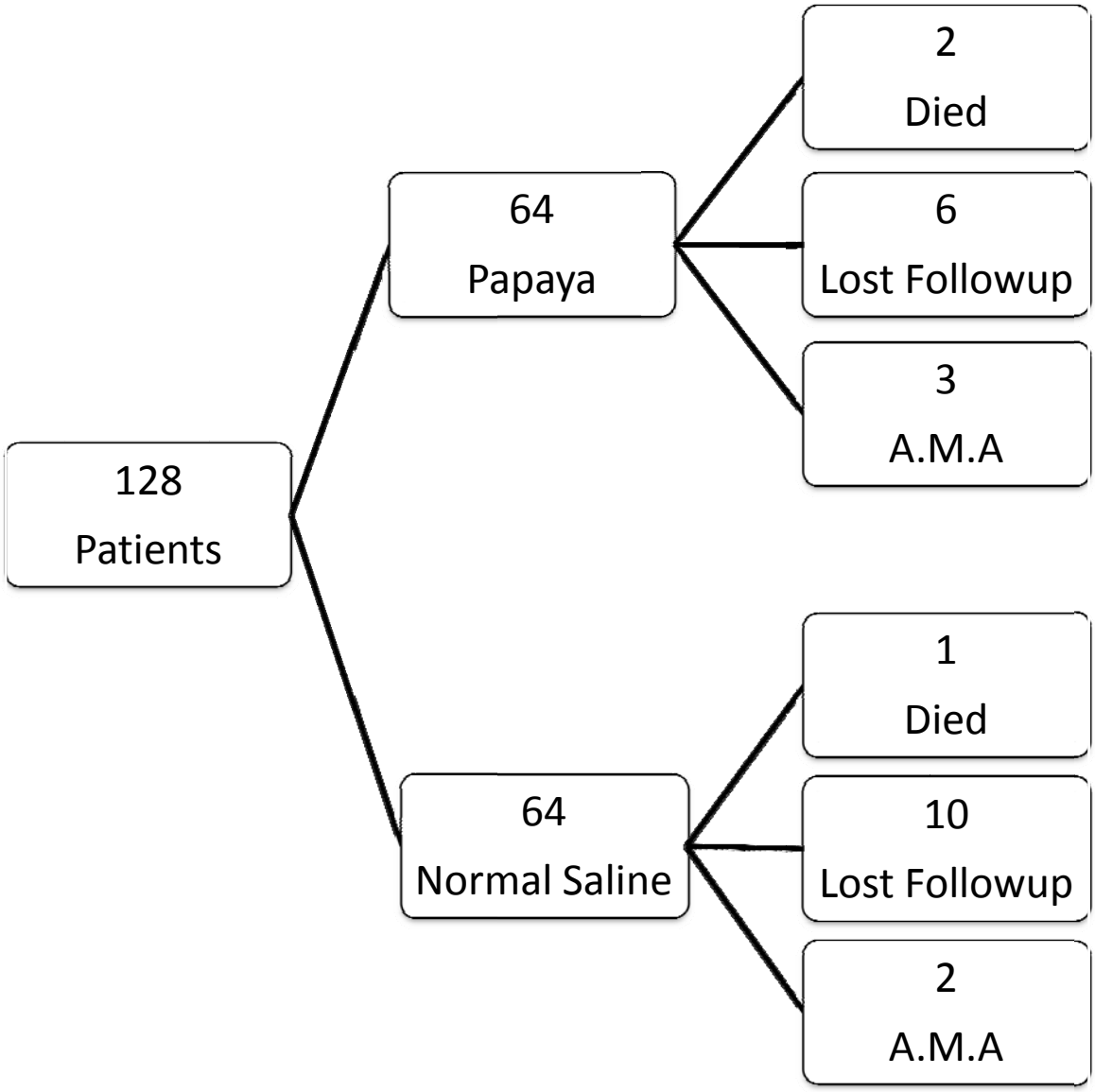
- Control group received wet to dry gauze dressing application with sterile gauze soaked with normal saline (0.9%) over the wound. Extra layers of abdominal pad placed over the moist gauze and twice daily dressing change was done [68].
- In the study group, ulcers were cleaned with normal saline and washed thoroughly. Semi ripe papaya was selected for all patients, washed and epicarp of the fruit was pealed and the fruit was grated finely and mashed into a paste and applied over the wound under sterile precaution [69]. Dry gauze was placed over the wound and dressing was applied.
- All the patients were treated till complete debridement.
- The reduction in slough and reduction in wound size in Sq.Cm. was assessed weekly from zero to four weeks. Granulation tissue formation in comparison to wound size was measured in percentage weekly till complete granulation. End point was presence of 100% healthy granulation tissue which was defined as pink tissue with beaded and granular appearance.
- At the end point, whether any secondary procedure like SSG or secondary suturing if done was noted and follows up was done for three months.

METHODS:

Study was initially started in 128 patients, 64 patients in each group after randomization.

- 16 patients lost follow up after treatment phase
- 3 patients died during the follow up phase (2 patients died of CVA & 1 patient died of MI)
- 5 patients went against medical advice during treatment phase
- There were remaining 104 patients, 53 patients in papaya group and 51 patients in normal saline group. First 50 patients in each group in the random table were taken into the study for comparison.

METHODS


128
Patients
64
Papaya
2
Died
6
Lost Followup
3
A.M.A
64
Normal Saline
1
Died
10
Lost Followup
2
A.M.A

STATISTICAL METHODS:

- Probability value (P Value) < 0.05 the null hypothesis was rejected i.e., P Value < 0.05 means there is significant relationship between the two tests.
- Student's t-test (t-test) was used to find the difference between means of the two groups.
- Chi square (x^2) test was used to find difference between percentages or proportions of categorical outcomes of the two groups.
- Other non parametric test used to find the significance was Fisher's exact test.

Clinical Photographs

WOUND HEALING WITH PAPAYA

0 WEEK

2nd WEEK

4th WEEK

ADDITIONAL TREATMENT - SSG

3rd MONTH

WOUND CONTRACTION WITH PAPAYA

1st WEEK

7th WEEK

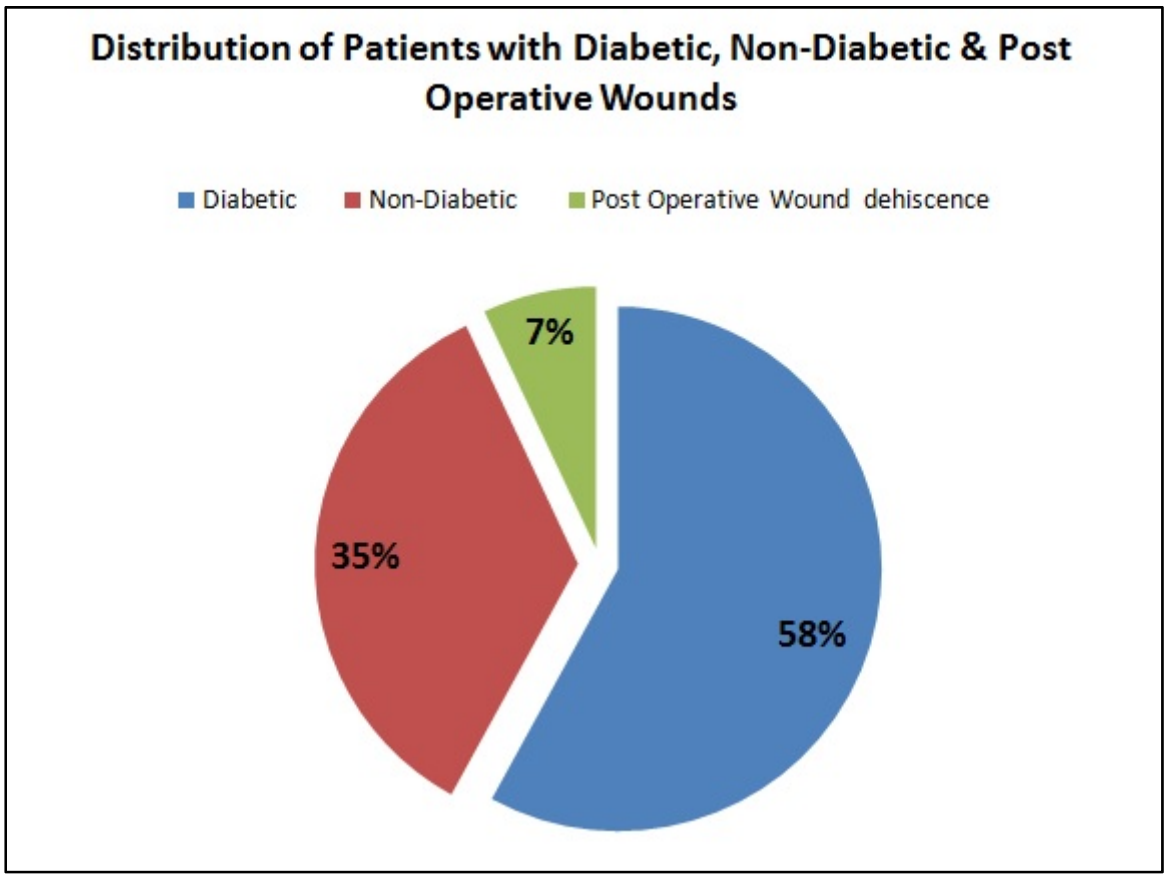
3rd MONTH

SLOUGH REDUCTION WITH DEBRIDEMENT

NORMAL SALINE DRESSING  0 WEEK	NORMAL SALINE DRESSING  4th WEEK
PAPAYA DRESSING  0 WEEK	PAPAYA DRESSING  4th WEEK

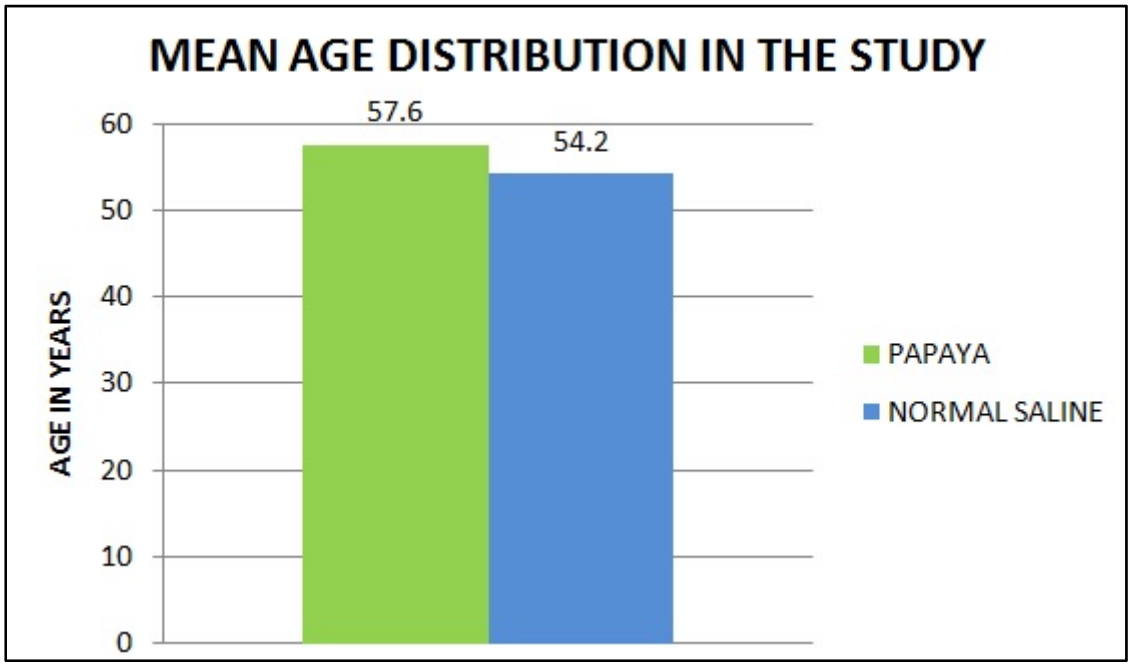
Data Analysis & Results

DISTRIBUTION OF PATIENTS IN THE STUDY GROUP



- 58% of the patients were diabetic in the study group.
- 35% were non-diabetic.
- 7% had post operative wound dehiscence. All were non-diabetic.

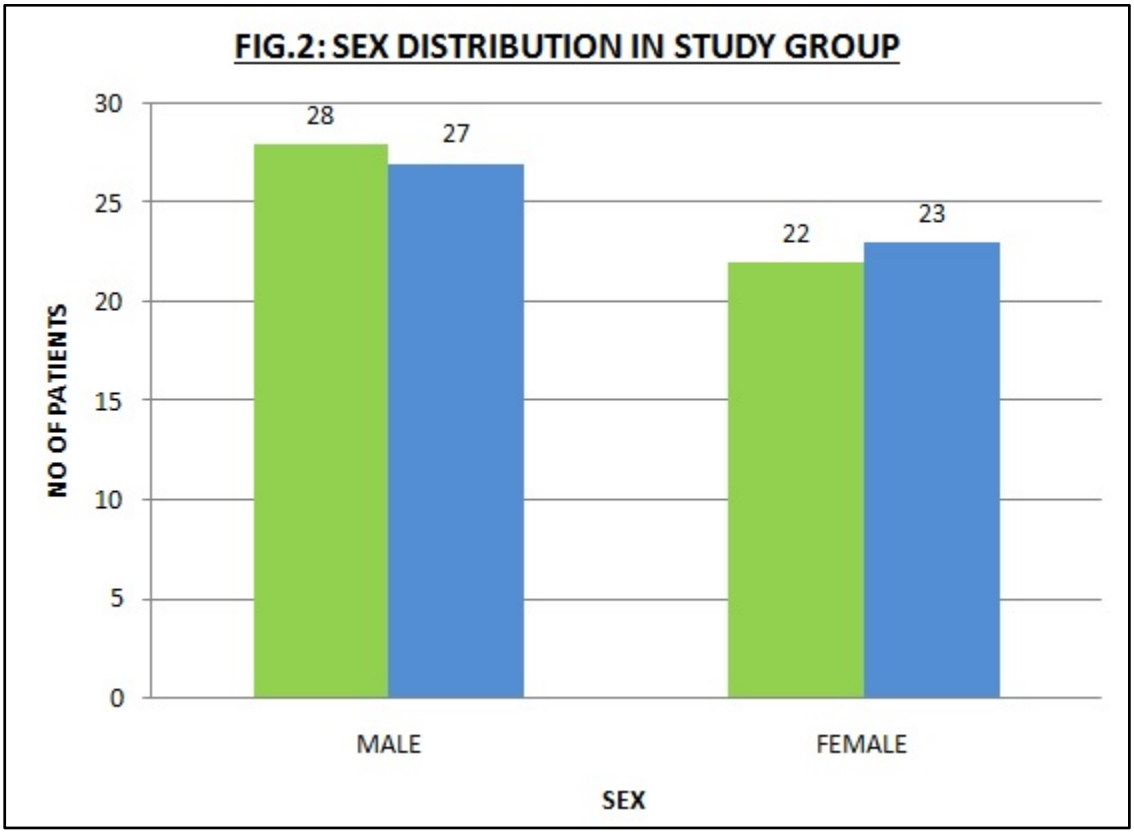
TABLE 1: MEAN AGE DISTRIBUTION IN THE STUDY



Group	N	Mean	Std.Dev	Minimum	Maximum	t-value	p-value
PAPAYA	50	57.6	9.4502	34	80	-1.9	0.0604
NORMAL SALINE	50	54.2	8.4201	37	71		
TOTAL		55.9	8.93515	36	76		

- Mean age in papaya group was **57.6 +/- 9.4502 yrs**.
- Mean age in normal saline group was **54.2 +/- 8.4201 yrs.**
- There was no significant difference between the two groups.

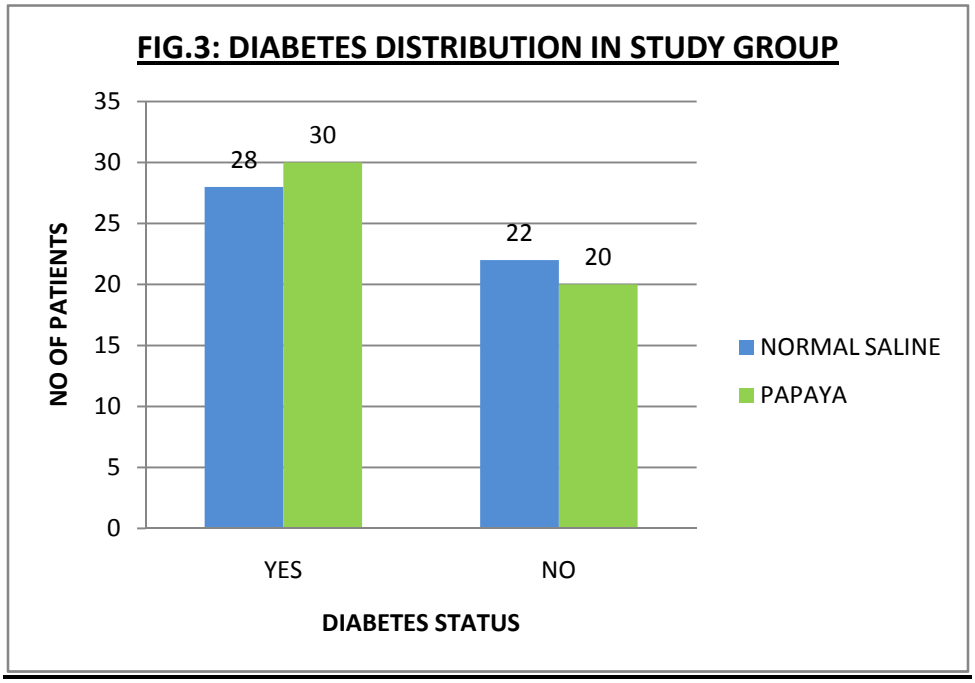
TABLE 2 : SEX DISTRIBUTION IN THE STUDY



SEX	DRESSING			Chi-square value	P-value
	NORMAL SALINE	PAPAYA	Total		
MALE	28	27	55	0.0404	0.8407
	56%	54%			
FEMALE	22	23	45		
	44%	46%			
Total	50	50	100		

- In papaya group : **54%** males and **46%** females
- In normal saline group : **56%** males and **44%** females.
- No significant difference between groups with respect to gender noted.

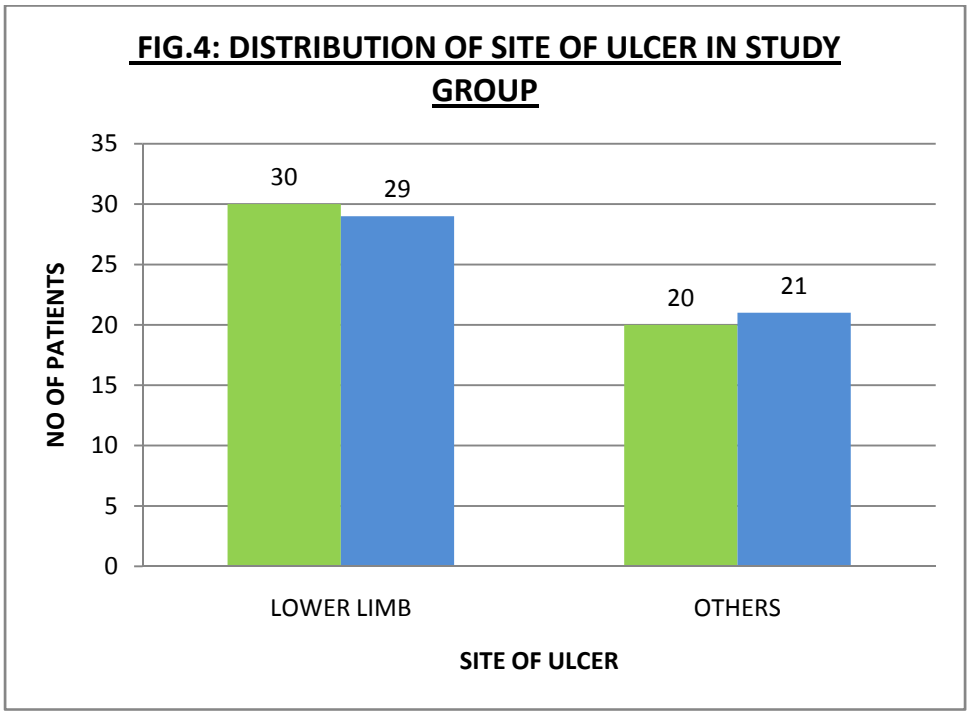
TABLE 3: DIABETES DISTRIBUTION IN THE STUDY



Diabetes status	Dressing			Chi-square value	P-value
	NORMAL SALINE	PAPAYA	Total		
YES	28	30	58	0.1642	0.6853
	56%	60%			
NO	22	20	42		
	44%	40%			
Total	50	50	100		

- The study has **58** diabetes patients and **42** non-diabetes patients
- In papaya group : **60%** diabetic patients and **40%** non-diabetes patients
- In normal saline group : **56%** diabetes patients and **44%** non-diabetes patients
- No significant difference between groups with respect to diabetes patients noted.

TABLE 4: DISTRIBUTION OF SITE OF ULCER IN THE STUDY

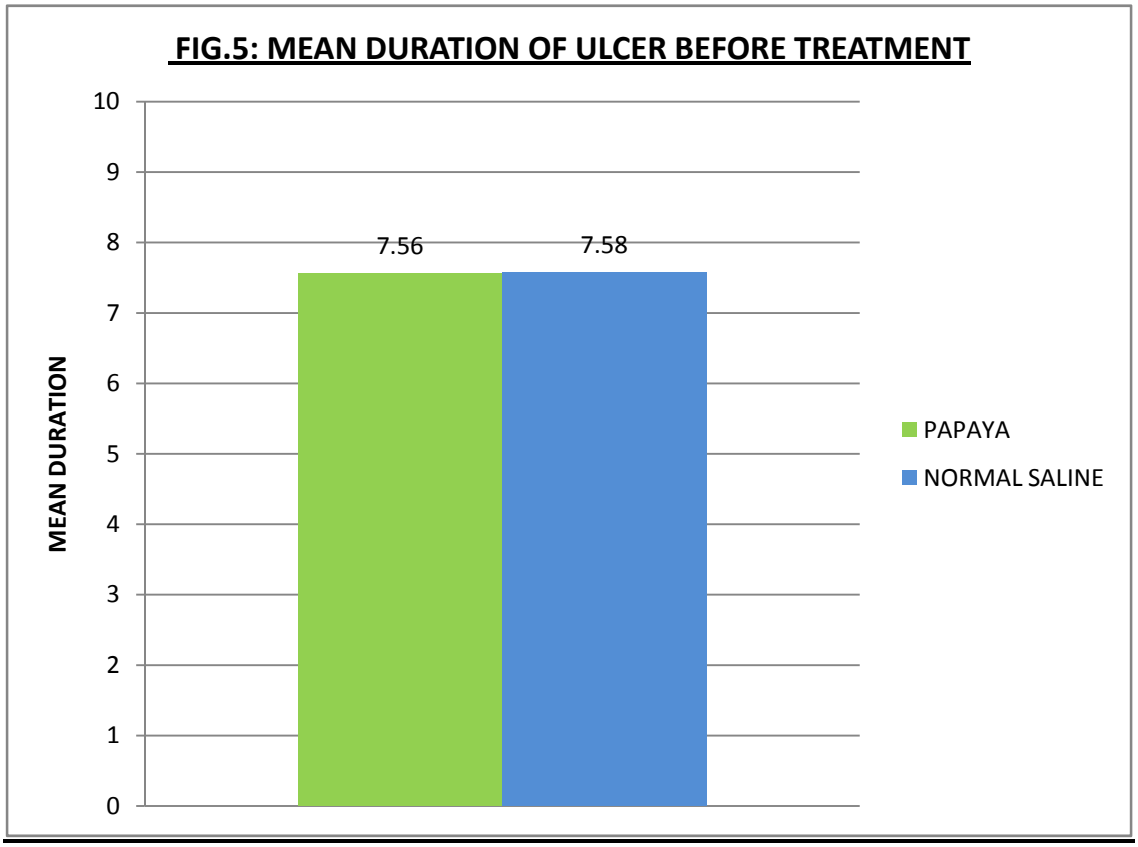


- Shows the study has **30%** have ulcer in right foot and **29%** have ulcer in left foot.
- Totally **59%** have ulcer in **lower limbs**.
- Other **41%** have ulcer in other areas like thighs, back, arms, scrotum and abdomen.

TABLE 4: DISTRIBUTION OF SITE OF ULCER IN THE STUDY

SITE OF ULCER	DRESSING		
	NORMAL SALINE	PAPAYA	Total
ABDOMEN	4	1	5
	8%	2%	
LEFT ANKLE	0	1	1
	0%	2%	
LEFT ARM	1	1	2
	2%	2%	
LEFT FOOT	16	14	30
	32%	28%	
LEFT GLUTEUS	0	1	1
	0%	2%	
LEFT LEG	2	3	5
	4%	6%	
LEFT THIGH	0	2	2
	0%	4%	
RIGHT ANKLE	2	3	5
	4%	6%	
RIGHT ARM	1	0	1
	2%	0%	
RIGHT ELBOW	1	1	2
	2%	2%	
RIGHT FOOT	14	15	29
	28%	30%	
RIGHT GLUTEUS	0	1	1
	0%	2%	
RIGHT HIP	1	2	3
	2%	4%	
RIGHT LEG	5	3	8
	10%	6%	
RIGHT THIGH	2	0	2
	4%	0%	
RIGHT UPPER BACK	0	1	1
	0%	2%	
SCROTUM	1	1	2
	2%	2%	
Total	50	50	100

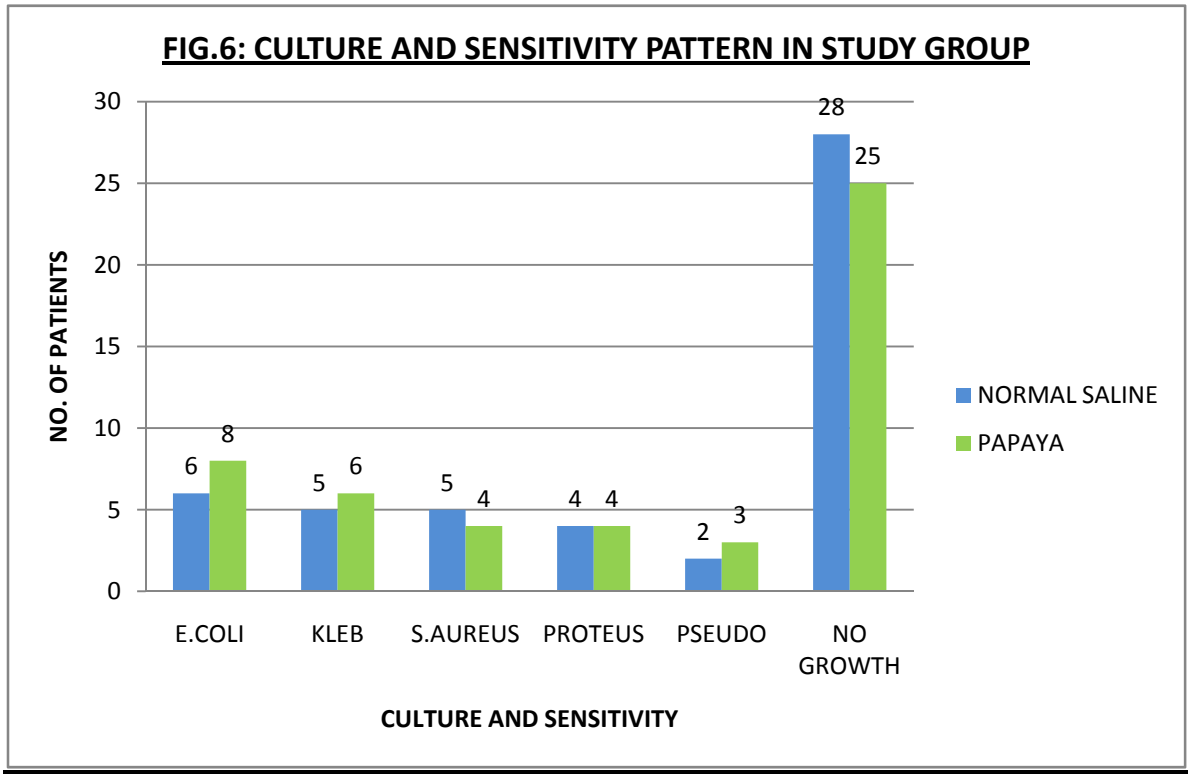
TABLE 5: MEAN DURATION OF ULCER BEFORE TREATMENT



Group	N	Mean	Std	Minimum	Maximum	t-value	P-value
PAPAYA	50	7.56	2.5964	3	15	0.04	0.9647
NORMAL SALINE	50	7.58	1.8416	4	12		
TOTAL	100	7.57	2.219	4	9		

- Mean duration of ulcer in papaya group was **7.56 +/- 2.5964 days**.
- Mean duration of ulcer in normal saline group was **7.58 +/- 1.8416 days.**
- There was no significant difference between the two groups.

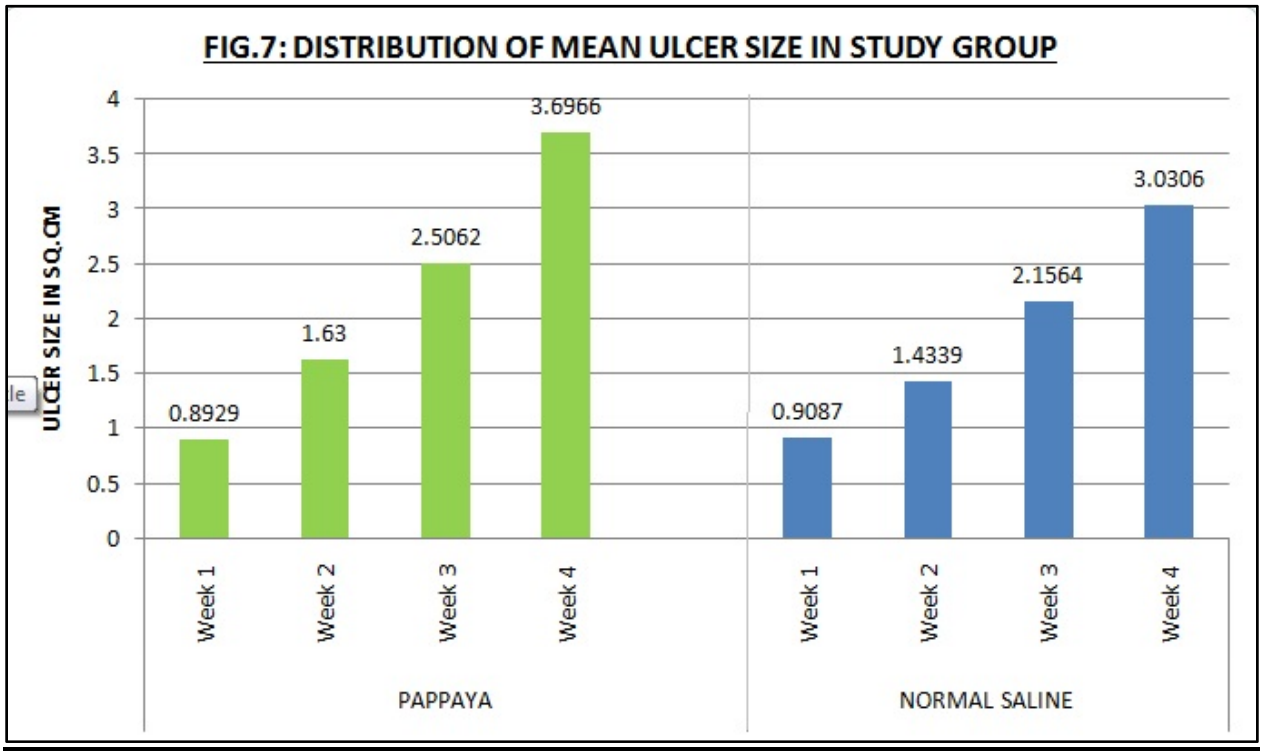
TABLE 6: CULTURE AND SENSITIVITY PATTERN IN THE STUDY



C/S	Dressing		
	NORMAL SALINE	PAPAYA	Total
E.COLI	6	8	14
	12%	16%	
KLEBSIELLA	5	6	11
	10%	12%	
S.AUREUS	5	4	9
	10%	8%	
PROTEUS	4	4	8
	8%	8%	
PSEUDOMONAS	2	3	5
	4%	6%	
NO GROWTH	28	25	53
	66%	50%	
Total	50	50	100

- Culture and sensitivity patterns in both groups were similar.
- Most frequently grown organism was **E.coli** followed by **Klebsiella.**

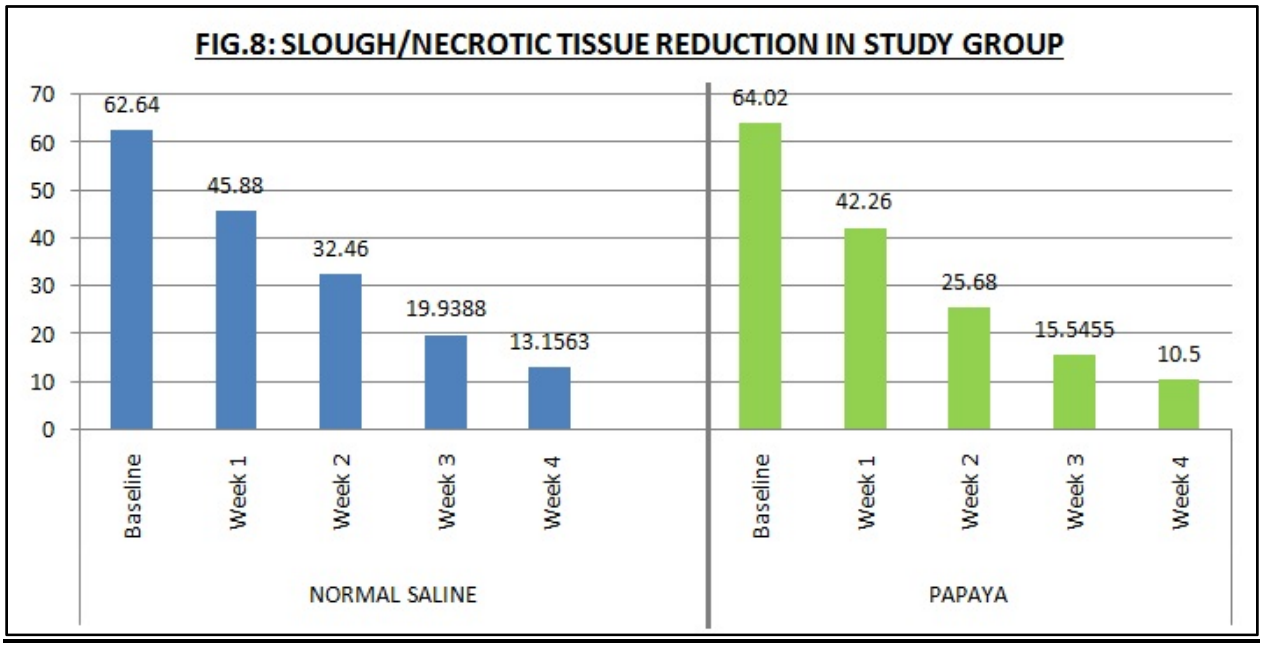
TABLE 7: DISTRIBUTION OF MEAN ULCER SIZE IN THE STUDY



Group	Time point	N	Mean	Std	Minimum	Maximum	t-value	P-value
PAPAYA	Week 1	34	0.8929	0.4081	0.32	2.11	12.76	<.0001
	Week 2	49	1.63	0.9775	0.32	4.37	11.67	<.0001
	Week 3	50	2.5062	1.504	0.5	7.32	11.78	<.0001
	Week 4	50	3.6966	2.1057	0.86	10.12	12.41	<.0001
NORMAL SALINE	Week 1	31	0.9087	0.4735	0.32	2.08	10.69	<.0001
	Week 2	49	1.4339	0.9097	0.33	4.33	11.03	<.0001
	Week 3	50	2.1564	1.2961	0.52	6.24	11.76	<.0001
	Week 4	50	3.0306	1.7232	0.89	8.47	12.44	<.0001

- Mean ulcer sizes in both groups were similar.
- Both groups showed reduction in ulcer size over the 4 weeks period.

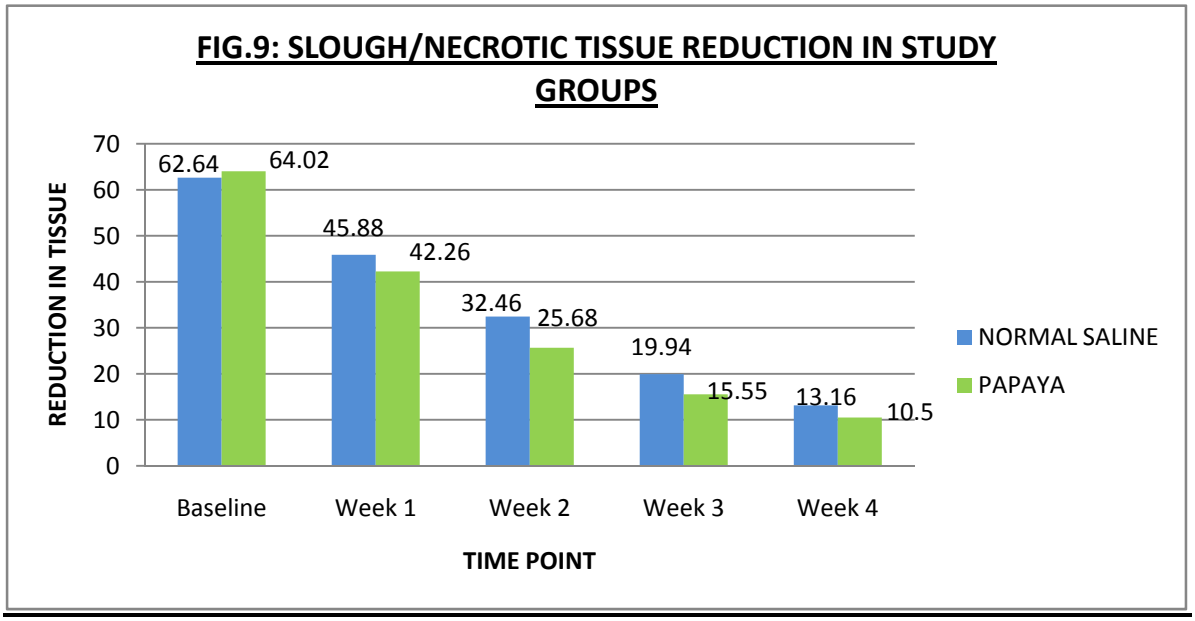
TABLE 8: SLOUGH/NECROTIC TISSUE REDUCTION WITHIN THE STUDY



Group	Time point	N	Mean	Std	Minimum	Maximum	Difference from baseline	p-value
NORMAL SALINE	Baseline	50	62.64	9.5335	40	78		
	Week 1	50	45.88	8.2329	21	62	-16.76	<.0001
	Week 2	50	32.46	6.792	12	54	-30.18	<.0001
	Week 3	49	19.9388	5.297	10	32	-43.1633	<.0001
	Week 4	32	13.1563	3.4558	8	20	-51.1875	<.0001
PAPAYA	Baseline	50	64.02	11.6488	32	84		
	Week 1	50	42.26	9.6549	21	68	-21.76	<.0001
	Week 2	50	25.68	9.0225	8	43	-38.34	<.0001
	Week 3	33	15.5455	4.8676	10	34	-51.2727	<.0001
	Week 4	2	10.5	0.7071	10	11	-61	0.0482

- There was significant difference in percentage reduction in slough / necrotic tissue within the two groups.

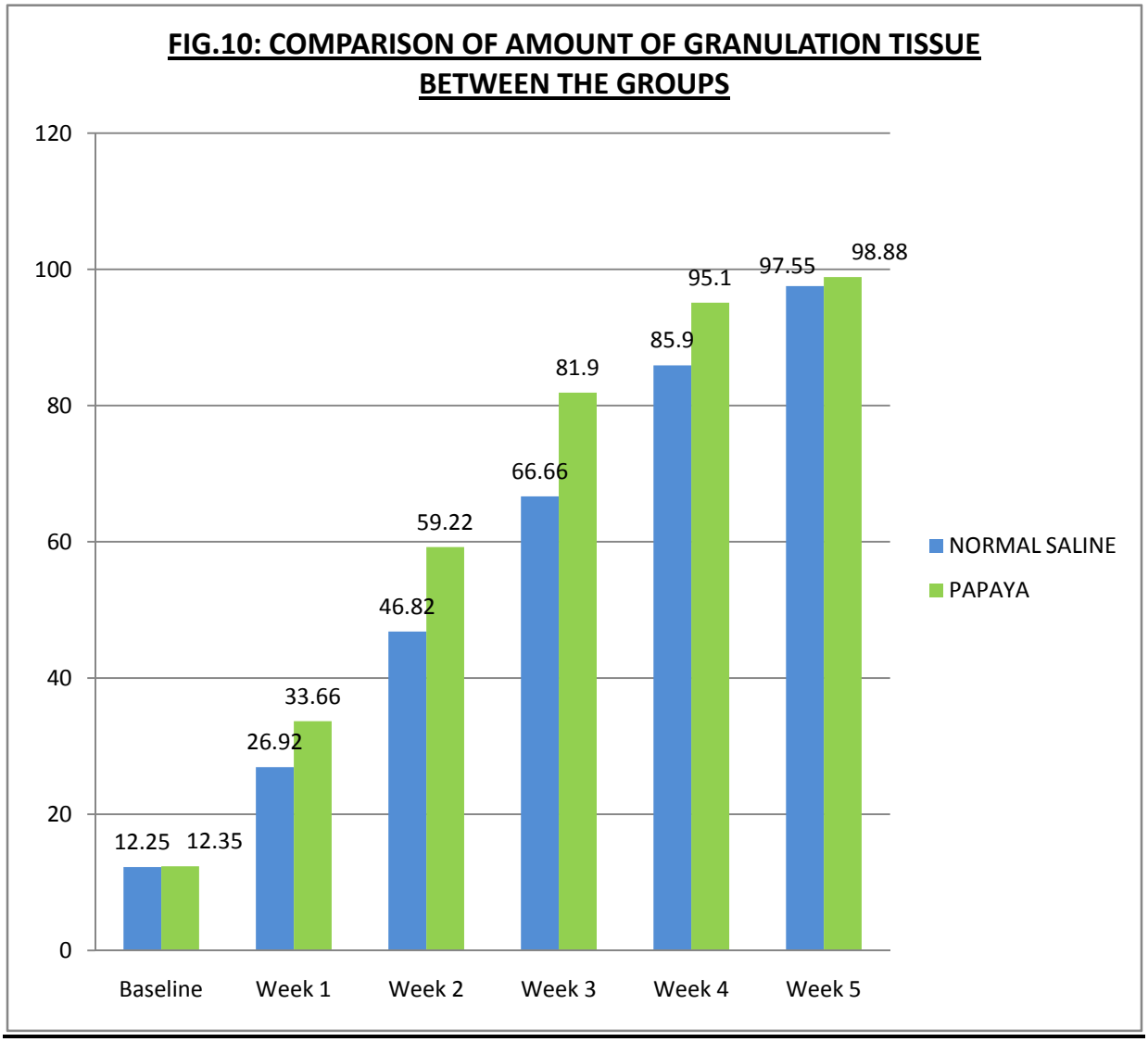
TABLE 9: SLOUGH/NECROTIC TISSUE REDUCTION BETWEEN THE STUDY GROUPS



	NORMAL SALINE		PAPAYA			
Time point	**N**	**Mean**	**N**	**Mean**	**Difference**	**p-value**
Baseline	50	62.64	50	64.02	-1.38	0.5183
Week 1	50	45.88	50	42.26	3.62	0.0464
Week 2	50	32.46	50	25.68	6.78	0.0494
Week 3	49	19.9388	33	15.5455	4.3933	0.0003
Week 4	32	13.1563	2	10.5	2.6563	0.0082

- There was significant difference in reduction in slough/necrotic tissue between the two groups.
- In the second week comparison p-Value was 0.049, third week it was 0.0003 and the fourth week it was 0.0082.
- Papaya group showed better slough reduction in **2nd, 3rd and 4th** weeks compared to normal saline.

TABLE 10: DISTRIBUTION OF WEEKWISE GRANULATION TISSUE FORMATION IN THE STUDY

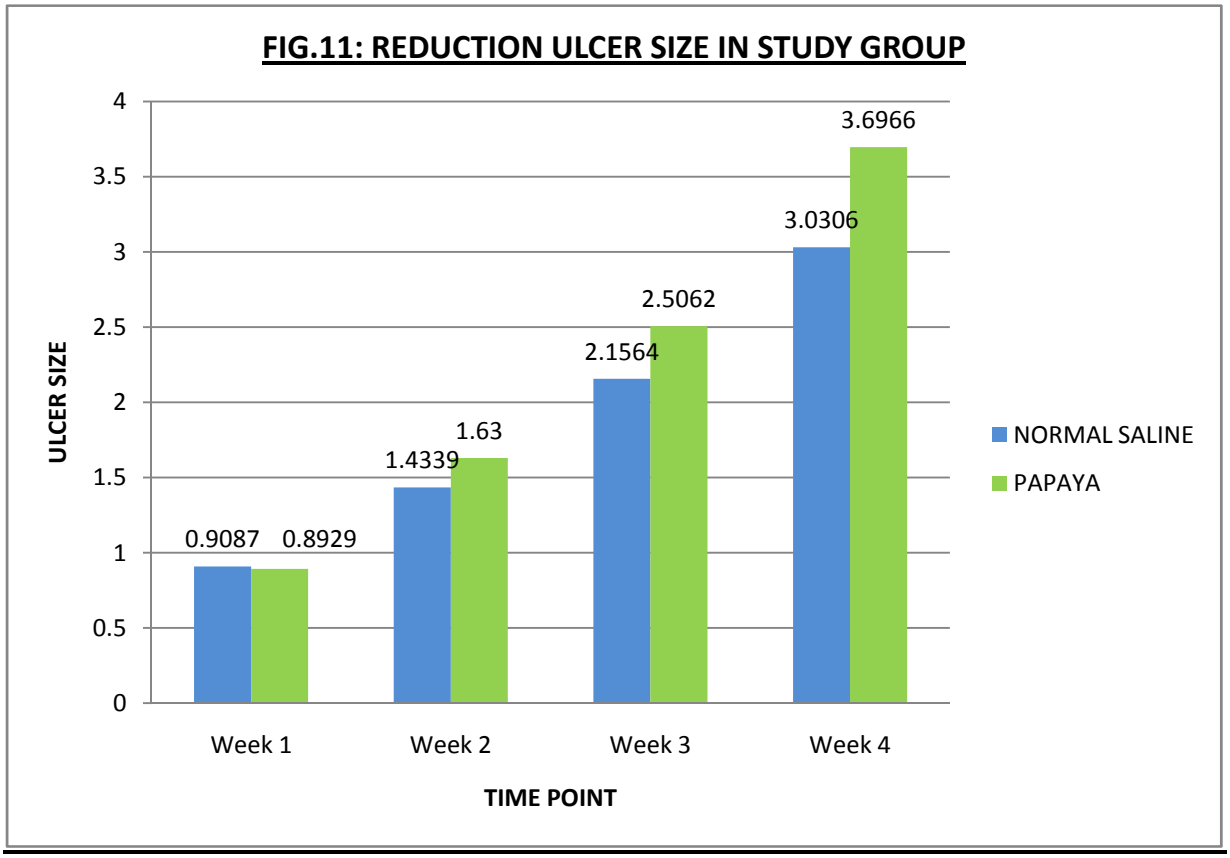


	NORMAL SALINE		PAPAYA			
Time point	**N**	**Mean**	**N**	**Mean**	**Difference**	**p-value**
Baseline	32	12.25	37	12.3514	-0.1014	0.9013
Week 1	50	26.92	50	33.66	-6.74	0.0008
Week 2	50	46.82	50	59.22	-12.4	<.0001
Week 3	50	66.66	50	81.9	-15.24	<.0001
Week 4	50	85.9	41	95.0976	-9.1976	<.0001
Week 5	40	97.55	16	98.875	-1.325	0.2704

TABLE 10: DISTRIBUTION OF WEEKWISE GRANULATION TISSUE FORMATION IN THE STUDY

- There was significant difference in percentage increase in granulation tissue in papaya group compared to normal saline group.
- Week wise comparison between the two groups showed that papaya showed better granulation tissue formation after **2^{nd} , 3^{rd}** & **4^{th}** weeks when compared to normal saline group.
- p-Value was less than 0.0001 at the end of 4^{th} week.

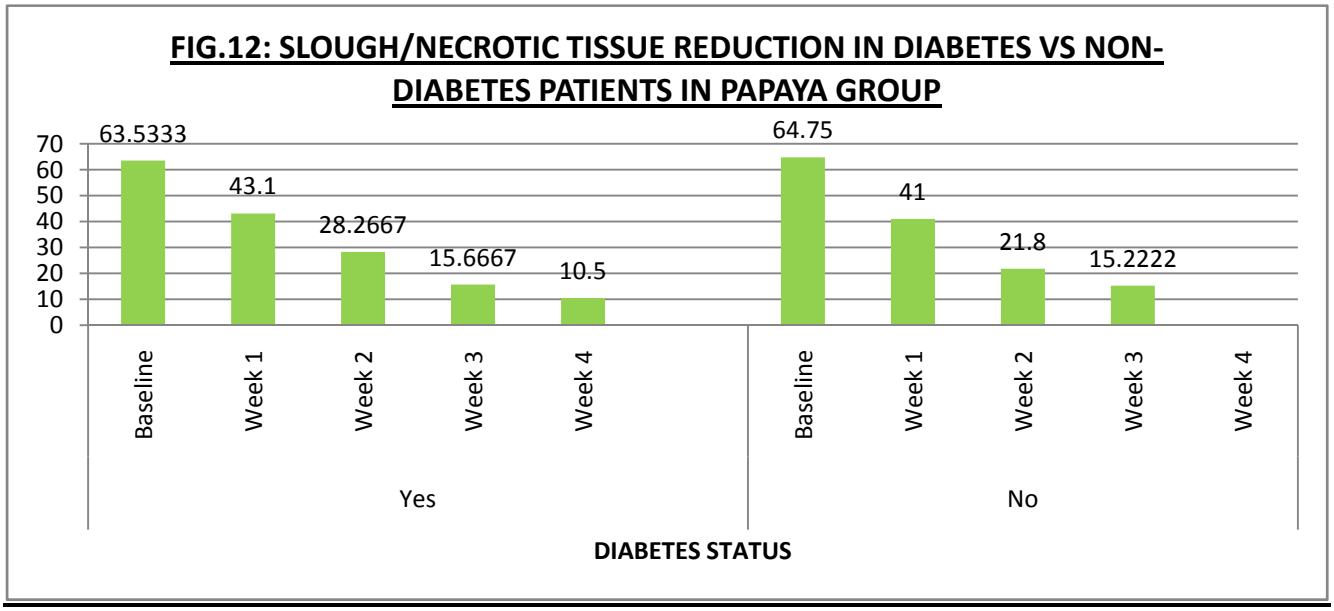
TABLE 11: DISTRIBUTION OF REDUCTION OF ULCER SIZE IN THE STUDY



	NORMAL SALINE		PAPAYA			
Time point	**N**	**Mean**	**N**	**Mean**	**Difference**	**p-value**
Week 1	31	0.9087	34	0.8929	0.0158	0.8858
Week 2	49	1.4339	49	1.63	-0.1961	0.3065
Week 3	50	2.1564	50	2.5062	-0.3498	0.2158
Week 4	50	3.0306	50	3.6966	-0.666	0.0866

- Week wise comparison of reduction in size of ulcer of ulcer did not show any significant difference.

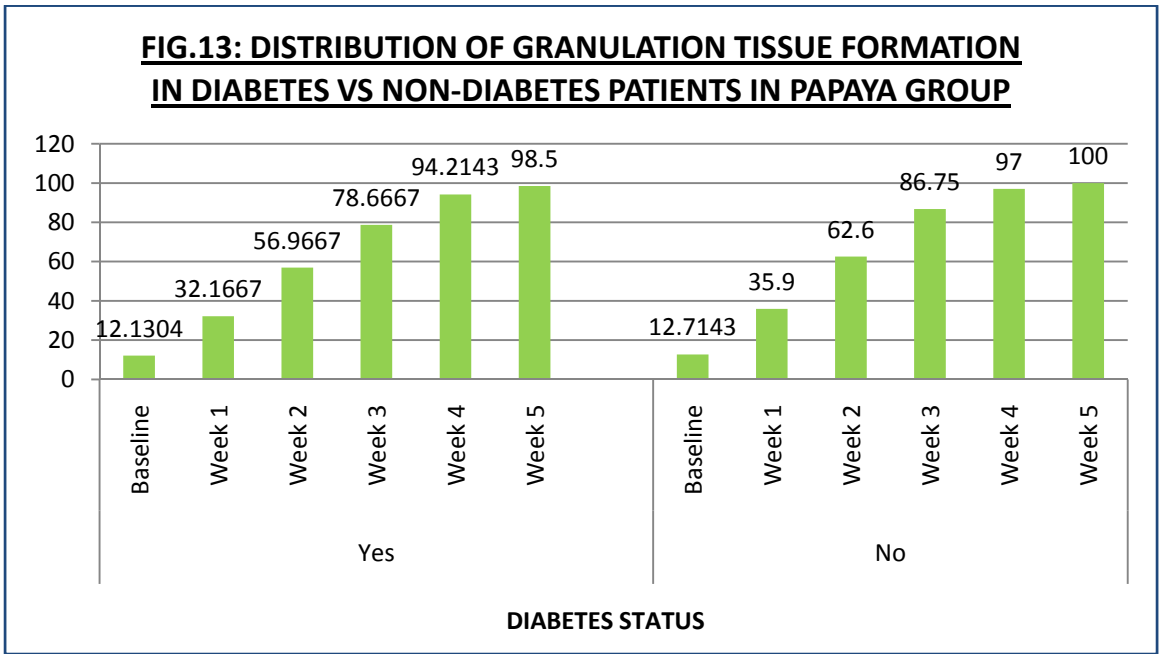
TABLE 12: SLOUGH/NECROTIC TISSUE REDUCTION IN DIABETES VS NON-DIABETES PATIENTS IN PAPAYA GROUP



Diabetes status	Time point	N	Mean	Std	Minimum	Maximum	Difference from baseline	p-value
Yes	Baseline	30	63.5333	12.0594	32	84		
	Week 1	30	43.1	10.2363	21	68	-20.4333	<.0001
	Week 2	30	28.2667	9.3769	8	43	-35.2667	<.0001
	Week 3	24	15.6667	5.3703	10	34	-50.75	<.0001
	Week 4	2	10.5	0.7071	10	11	-61	0.0521
No	Baseline	20	64.75	11.2712	42	78		
	Week 1	20	41	8.8139	26	54	-23.75	<.0001
	Week 2	20	21.8	7.0233	12	33	-42.95	<.0001
	Week 3	9	15.2222	3.4197	11	20	-52.6667	<.0001
	Week 4	0						

- There is no significant difference in reduction of slough/necrotic tissue between diabetes and non-diabetes patients.

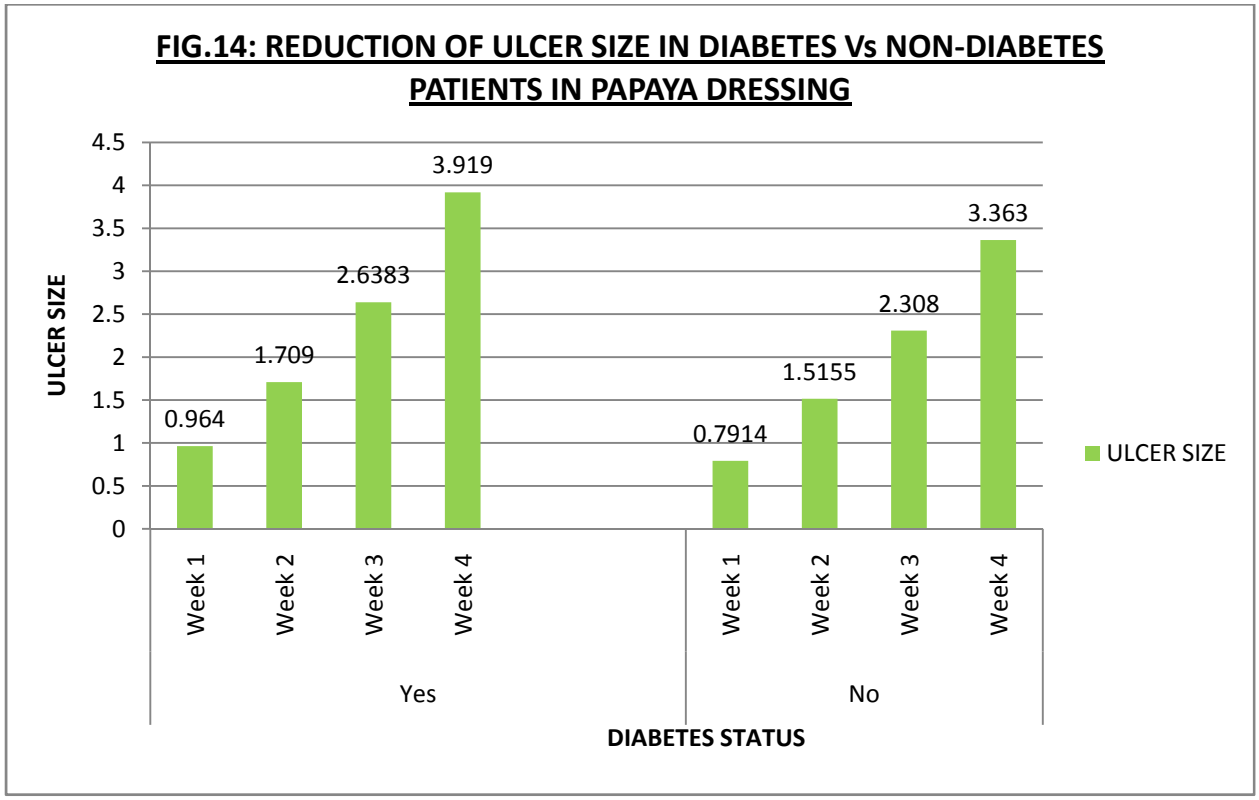
TABLE 13: DISTRIBUTION OF GRANULATION TISSUE FORMATION IN DIABETES VS NON-DIABETES PATIENTS IN PAPAYA GROUP



Diabetes status	Time point	N	Mean	Std	Minimum	Maximum	Difference from baseline
Yes	Baseline	23	12.1304	3.8412	6	19	
	Week 1	30	32.1667	11.0706	12	57	24.3913
	Week 2	30	56.9667	11.4786	34	79	48.4783
	Week 3	30	78.6667	10.8924	56	100	68.087
	Week 4	28	94.2143	7.4851	79	100	82.8571
	Week 5	12	98.5	3.5291	90	100	89.3333
No	Baseline	14	12.7143	2.9982	8	19	
	Week 1	20	35.9	12.0783	14	58	28.5
	Week 2	20	62.6	11.2034	42	78	52.2143
	Week 3	20	86.75	11.5434	60	100	75.0714
	Week 4	13	97	4.761	88	100	82.25
	Week 5	4	100	0	100	100	87.75

- There is no significant difference in formation of granulation tissue between diabetic and non diabetic patients.

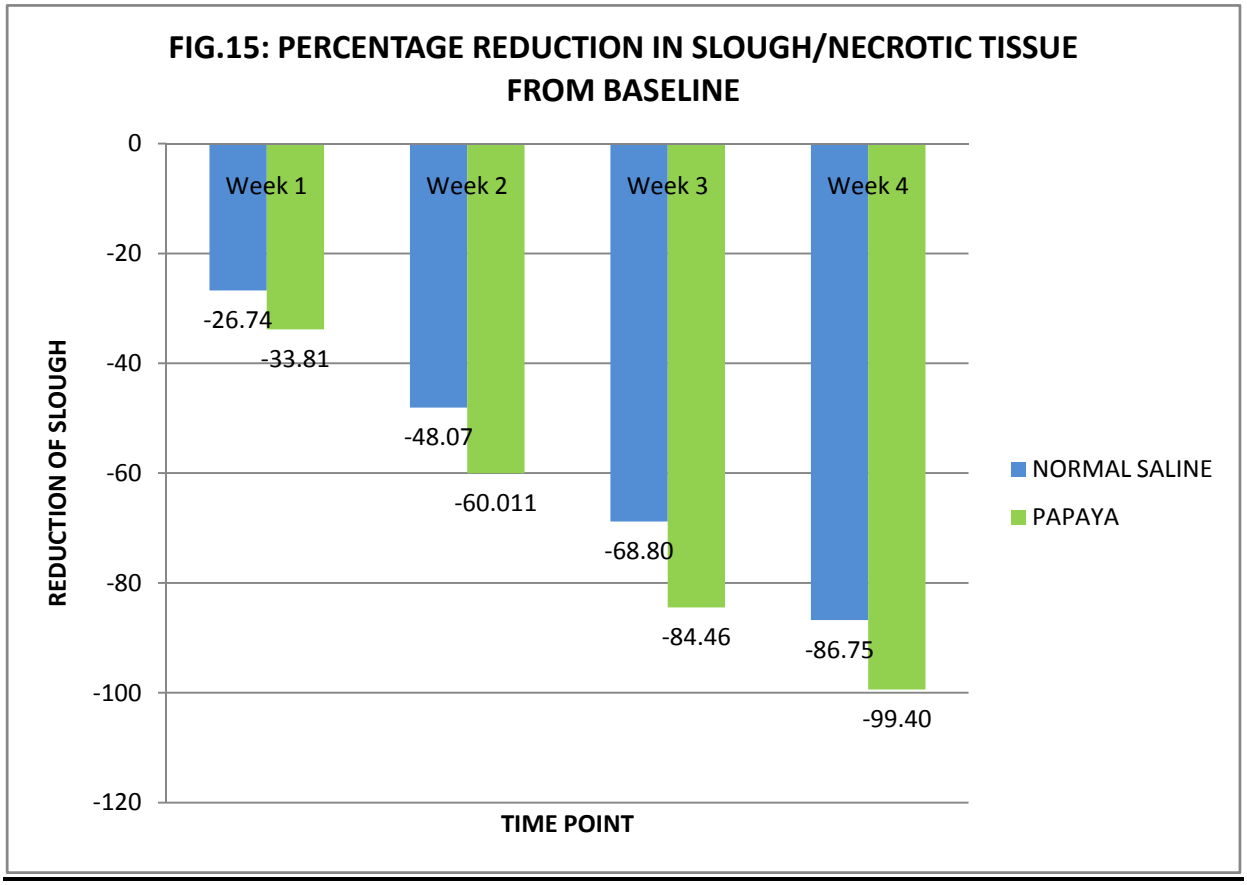
TABLE 14: REDUCTION OF ULCER SIZE IN DIABETES Vs NON-DIABETES PATIENTS IN PAPAYA DRESSING



- There was no significant reduction in ulcer size between diabetic and non diabetic patients.

Diabetes Status	Time point	N	Mean	Std	Minimum	Maximum	t-value
Yes	Week 1	20	0.964	0.4304	0.41	2.11	10.02
	Week 2	29	1.709	1.0265	0.4	4.37	8.97
	Week 3	30	2.6383	1.5577	0.5	7.32	9.28
	Week 4	30	3.919	2.1519	0.86	10.12	9.98
No	Week 1	14	0.7914	0.365	0.32	1.54	8.11
	Week 2	20	1.5155	0.9152	0.32	3.16	7.41
	Week 3	20	2.308	1.4357	0.84	5.27	7.19
	Week 4	20	3.363	2.0424	1.12	8.31	7.36

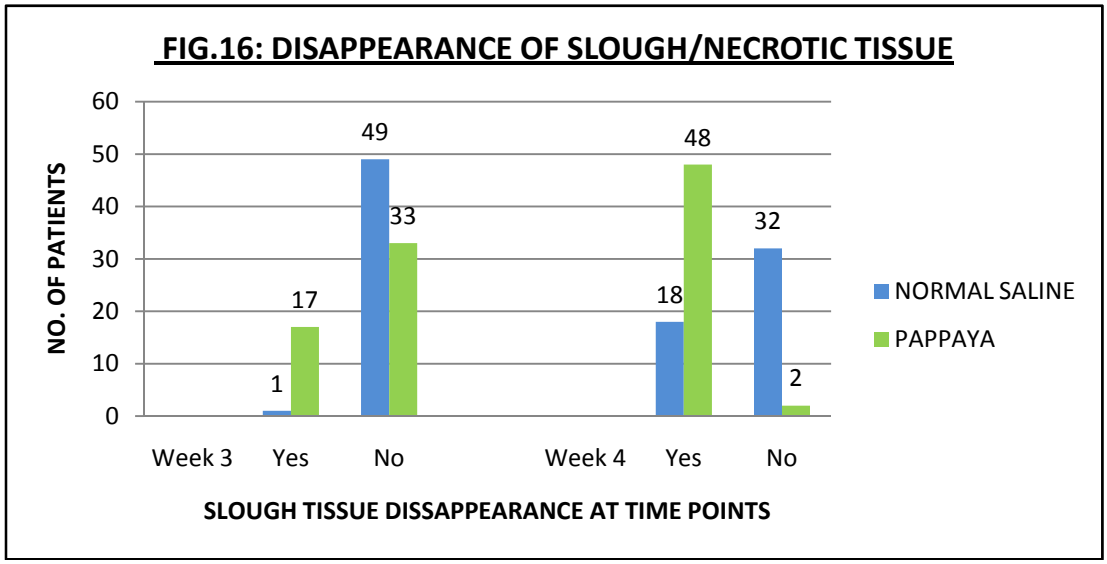
TABLE 15: PERCENTAGE REDUCTION IN SLOUGH / NECROTIC TISSUE FROM BASELINE



	NORMAL SALINE		PAPAYA			
Time point	**N**	**Mean**	**N**	**Mean**	**Difference**	**p-value**
Week 1	50	-26.7402	50	-33.8116	7.0714	0.0001
Week 2	50	-48.0757	50	-60.011	11.9353	<.0001
Week 3	50	-68.8044	50	-84.4574	15.6531	<.0001
Week 4	50	-86.7518	50	-99.4085	12.6567	<.0001

- There was significant difference in percentage reduction in slough necrotic tissue in papaya group compared to normal saline group.

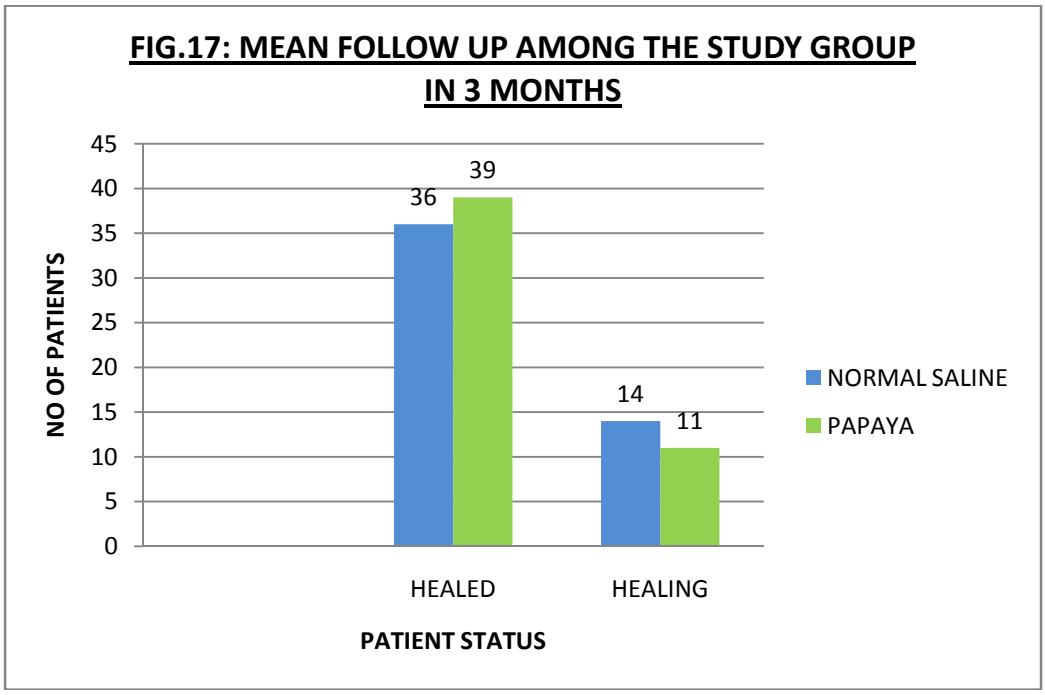
TABLE 16: REDUCTION IN SLOUGH/NECROTIC TISSUE



Complete disappearance of slough tissue	NORMAL SALINE	PAPAYA	p-value (fisher exact test)
	N (%)	N (%)	
Week 3			
Yes	1 (2.0)	17 (34.0)	<.0001
No	49 (98.0)	33 (66.0)	
Week 4			
Yes	18 (36.0)	48 (96.0)	<.0001
No	32 (64.0)	2 (4.0)	

- Disappearance of slough/necrotic tissue was more significant in papaya group in **3rd and 4th** week when compared to normal saline group.

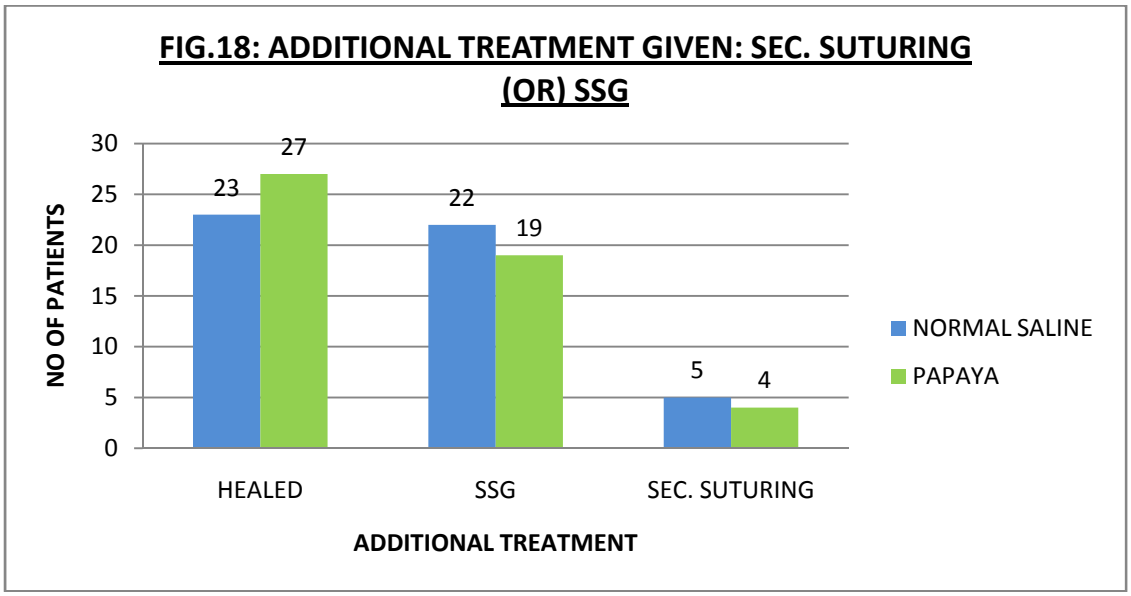
TABLE 17: MEAN FOLLOW UP AMONG THE STUDY GROUP AFTER 3 MONTHS



Status	Dressing			Chi-square	p-value
	NORMAL SALINE	PAPAYA	Total		
HEALED	36	39	75	0.48	0.4884
	72%	78%			
HEALING	14	11	25		
	28%	22%			
Total	50	50	100		

- At third month follow up showed 78% of wounds treated with papaya were completely healed and 22% were healing.
- 72% of wounds treated with normal saline were completely healed and 28% were healing.

TABLE 18: ADDITIONAL TREATMENT: SSG / SECONDARY SUTURING



ADDITIONAL TREATMENT	Dressing		
	NORMAL SALINE	PAPAYA	Total
HEALED	23	27	50
	46%	54%	
SSG	22	19	41
	44%	38%	
SEC. SUTURING	5	4	9
	10%	8%	
Total	50	50	100

- 22 patients underwent SSG in normal saline group and 19 patients in papaya group
- 5 patients underwent secondary suturing in normal saline group and 4 patients in papaya group
- 23 patients in normal saline group and 27 patients in papaya group did not require any additional treatment.

Discussion

DISCUSSION

Enzymatic chemical debriding agents like collagenase, pure papain and papain urea combinations have been in practice for wound bed preparation. Enzymatic debridement with papaya is a cost effective , easily available and is eco friendly also.

A detailed literature search revealed several anecdotal reports, various review articles and few methodical studies which have analyzed the enzymatic action of papaya fruit, in diabetic ulcers, post operative wound dehiscence in western population and in diabetic rats. Based on these reports, it was decided to study the effects of papaya in wound bed preparation.

Our study results have shown that there is significant difference (p-Value < 0.001) in granulation tissue formation with papaya dressing when compared to normal saline dressing in third and fourth weeks. This is attributed to granulation tissue formation induced by Papain and chymopapain. Slough reduction with papaya was also significant, as 96% of the patients were completely cleared of slough at the end of fourth week, when compared to 36% with normal saline dressing. The p- value was (0.0082) significant during second, third and fourth week of the papaya dressing.

There was no significant reduction in ulcer size (p-value of 0.086) when compared to normal saline. Reductions in ulcer size in both groups were similar. In well controlled diabetes mellitus, papaya can be used as a debriding agent safely. Wet to dry normal saline dressings is routinely employed for wound dressings, as it is cost effective and easily available. But in comparison to papaya it takes a longer duration for healing and time consuming.

There was no hypersensitivity, tolerability or side effects in both the groups, as previous studies have already confirmed the safety and tolerability aspects of papaya. It has been reported that some pure papain preparations have been associated with pain, itching and hypersensitivity reactions. Despite such concerns no such hypersensitivity was seen in this study. Patient has to be clearly instructed to use semi ripe papaya since raw papaya application is associated with pain.

Limitations of this study are related to lack of standardized methods of papaya preparation. The enzymatic content of papaya is said to decrease as fruit ripens, suggesting a better efficacy in semi ripe papaya. In spite of difference in enzyme content as the fruit ripens, previous studies confirm that there is no difference is in antibacterial activity in ripe and unripe fruit.

Papaya dressing can be encouraged as papaya is easily available in India throughout the year and cost effective also. Preparation and application of papaya dressing is also easy and can be done by unskilled personnel. Thus in terms of efficacy, papaya dressing can be a good and better dressing method compared to normal saline dressing.

Conclusion

CONCLUSION

- Papaya dressing and normal saline dressing have proven efficacy in debridement of wounds.
- Papaya dressing is a better enzymatic agent when compared to wet to dry normal saline mechanical debridement.
- Papaya dressing was found to remove slough and necrotic tissue more rapidly when compared to normal saline as per our study.
- Wounds treated with papaya dressing had a faster granulation tissue formation compared to normal saline dressing.
- There was no significant difference in reduction in ulcer size between the two groups in this study.
- Overall response to treatment with papaya dressing was significantly better when compared to normal saline dressing.

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Proforma

PROFORMA

NAME :

AGE :

SEX :

IP NUMBER :

SOCIO ECONOMIC STATUS :

CHIEF COMPLAINTS :

COMORBID CONDITIONS :

PAST HISTORY :

ULCER (Examination):

- Duration
- Site
- Size
- Number
- Discharge
- Margins & edges
- Induration

INVESTIGATIONS:

- Haemoglobin
- Total counts
- Differential counts
- RFT
- LFT
- Culture & Sensitivity
- X Ray (if required)

TYPE OF DRESSING:

- Papaya
- Normal saline

ASSESSMENT OF TREATMENT:

	1st Week	2nd Week	3rd Week	4th Week
Reduction in size				
Reduction in slough				
Granulation tissue				
Over-all clinical response				
Side Effects				
Total follow up				
Additional treatment				

Master Chart

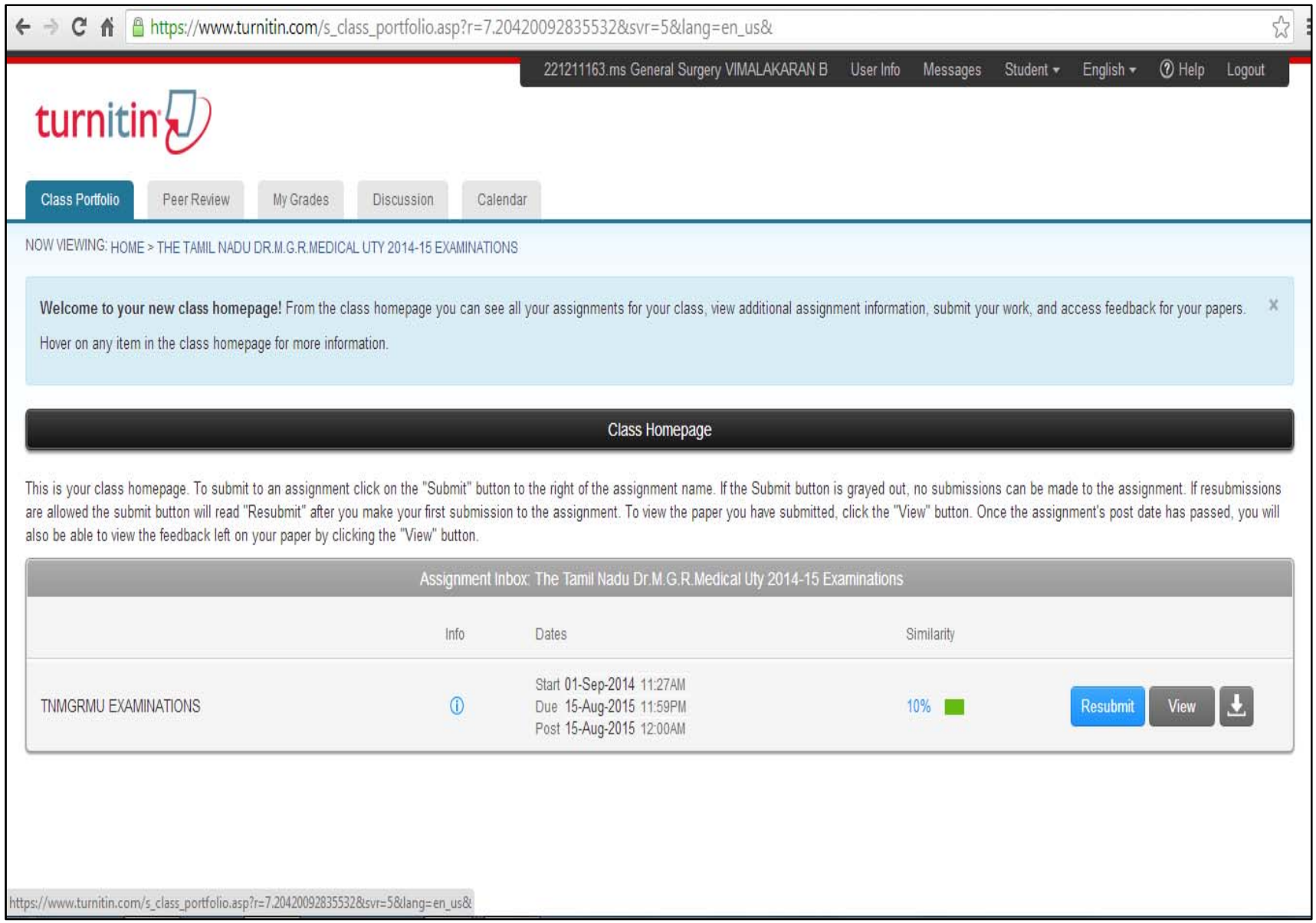
MASTER CHART

S.NO	NAME	AGE	SEX	ULCER AREA Sq.cm	SITE	DURATION	DIABETES	DRESSING	REDUCTION IN ULCER SIZE				REDUCTION IN SLOUGH					GRANULATION TISSUE						C/S	ADDITIONAL TREATMENT	FOLLOW-UP 3RD MONTH
									1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	5wk			
1	GUNASEELAN	57	M	138.56	LT FOOT	6	YES	N.S.(0.9%)	0.32	1.44	3.21	4.37	64%	42%	28%	20%	11%	-	14%	37%	54%	78%	96%	PSEUDO	SSG	HEALED
2	RADHA	62	F	60.21	RT HIP	6	NO	PAPAYA	0.32	0.98	1.12	1.87	78%	32%	14%	NIL	-	-	14%	54%	82%	100%	-	-	SEC. SUTURING	HEALED
3	VIJAYAKUMAR	65	M	80.41	LT LEG	9	NO	N.S.(0.9%)	0.32	0.9	1.18	1.7	66%	56%	41%	30%	18%	8%	24%	45%	62%	81%	100%	-	-	HEALING
4	MICHAEL	70	M	52.08	RT FOOT	6	YES	PAPAYA	0.41	0.86	1.12	1.7	41%	28%	12%	NIL	-	12%	44%	69%	100%	-	-	-	-	HEALED
5	PARVATHY	71	F	42.16	RT FOOT	7	NO	PAPAYA	0.42	1.24	1.8	2.11	58%	40%	21%	11%	NIL	19%	39%	52%	79%	100%	-	-	SSG	HEALED
6	PASUVIAH	62	M	72.74	LT ARM	4	NO	PAPAYA	0.42	0.98	1.21	1.95	44%	26%	12%	NIL	-	14%	56%	75%	100%	-	-	E.COLI	-	HEALED
7	RANGANATHAN	57	M	82.8	RT FOOT	5	NO	PAPAYA	0.45	0.96	1.3	2.9	69%	50%	27%	14%	NIL	-	22%	48%	79%	100%	-	E.COLI	-	HEALED
8	DINAKAR BABU	45	M	78.46	RT FOOT	7	YES	N.S.(0.9%)	0.52	1.12	1.63	2.17	52%	40%	31%	19%	10%	-	19%	36%	64%	86%	100%	-	-	HEALED
9	SIRAJJUDIN	52	M	104.73	LT FOOT	8	NO	N.S.(0.9%)	0.52	0.89	1.43	2.78	74%	62%	54%	32%	19%	10%	22%	47%	63%	81%	90%	KLEB	SSG	HEALING
10	SRINIVASAN	58	M	117.63	LT FOOT	7	YES	N.S.(0.9%)	0.52	1.47	2.23	3.76	68%	44%	27%	17%	13%	11%	31%	48%	62%	84%	100%	PROTEUS	SSG	HEALED
11	BEULAH	50	F	99.46	RT ARM	4	YES	N.S.(0.9%)	0.54	1.22	1.87	2.96	54%	39%	26%	20%	15%	8%	24%	49%	67%	84%	100%	E.COLI	-	HEALED
12	KOTEESHWARI	44	F	96.54	LT FOOT	8	YES	N.S.(0.9%)	0.54	1.12	1.99	2.41	70%	44%	31%	14%	NIL	-	26%	58%	76%	91%	100%	S.AUREUS	-	HEALED
13	MUNUSAMY	50	M	69.69	LT FOOT	8	YES	PAPAYA	0.54	1.32	2.75	4.46	84%	68%	39%	16%	NIL	-	18%	46%	78%	100%	-	PROTEUS	-	HEALED
14	PANDIYAN	49	M	101.38	RT LEG	7	YES	N.S.(0.9%)	0.54	1.1	1.75	2.45	71%	50%	31%	20%	8%	-	18%	36%	62%	81%	100%	-	SSG	HEALED
15	RAMAN SINGH	50	M	14.52	LT FOOT	6	NO	PAPAYA	0.54	0.87	1.02	1.12	42%	30%	17%	NIL	-	14%	58%	75%	100%	-	-	-	-	HEALED
16	THENAPPAN	66	M	56.86	RT FOOT	7	YES	N.S.(0.9%)	0.54	0.98	1.43	1.92	71%	60%	42%	24%	16%	15%	38%	54%	76%	100%	-	-	-	HEALED
17	SEKAR	47	M	124.56	LT FOOT	7	YES	N.S.(0.9%)	0.56	1.8	2.76	3.89	71%	56%	40%	24%	10%	14%	29%	49%	68%	85%	100%	-	SSG	HEALING
18	MUTHU LAKSHMI	64	F	72.44	LT FOOT	9	NO	N.S.(0.9%)	0.57	1.22	1.97	2.21	68%	50%	39%	24%	18%	16%	34%	52%	67%	86%	100%	-	-	HEALED
19	BALAJI	51	M	84.32	LT FOOT	7	YES	PAPAYA	0.62	1.21	1.78	2.34	62%	41%	30%	14%	NIL	-	15%	53%	78%	100%	-	PROTEUS	SSG	HEALED
20	GEETHA	48	F	84.37	LT FOOT	10	NO	N.S.(0.9%)	0.62	0.9	1.21	2.64	64%	50%	38%	20%	NIL	16%	39%	51%	64%	80%	92%	-	-	HEALING
21	SAROJA	65	F	98.75	RT FOOT	5	YES	N.S.(0.9%)	0.64	1.75	2.4	3.22	72%	49%	30%	21%	14%	11%	26%	50%	69%	87%	100%	S.AUREUS	-	HEALING
22	THAKKALI	65	M	82.01	RT FOOT	5	NO	PAPAYA	0.66	2.76	3.91	5.54	66%	50%	28%	12%	NIL	9%	46%	70%	91%	100%	-	-	SSG	HEALED
23	IRUDHAYARAJ	44	M	55.61	LT GLUTEUS	7	YES	PAPAYA	0.67	1.87	3.92	5.43	76%	47%	26%	10%	NIL	-	12%	46%	86%	100%	-	-	SSG	HEALED
24	PERUMAL	62	M	97.85	RT FOOT	9	YES	N.S.(0.9%)	0.71	1.24	1.93	2.45	63%	49%	37%	23%	10%	12%	30%	44%	69%	80%	92%	-	-	HEALING
25	PHILIP	61	M	92.74	RT FOOT	8	YES	PAPAYA	0.72	1.12	1.83	2.86	58%	40%	26%	11%	NIL	12%	37%	65%	87%	100%	-	-	SSG	HEALED

S.NO	NAME	AGE	SEX	ULCER AREA Sq.cm	SITE	DURATION	DIABETES	DRESSING	REDUCTION IN ULCER SIZE				REDUCTION IN SLOUGH					GRANULATION TISSUE						C/S	ADDITIONAL TREATMENT	FOLLOW-UP 3RD MONTH
									1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	5wk			
26	RAVANAIAH	49	M	47.22	SCROTUM	4	NO	PAPAYA	0.73	1.2	1.76	2.1	68%	42%	20%	NIL	-	-	18%	60%	78%	100%	-	-	SEC. SUTURING	HEALED
27	ANGAMMAL	60	F	73.81	RT FOOT	12	YES	PAPAYA	0.75	2.14	3.55	4.2	58%	42%	29%	16%	NIL	12%	31%	58%	77%	92%	100%	E.COLI	SSG	HEALED
28	PERIYASAMY	54	M	124.56	LT FOOT	8	NO	N.S.(0.9%)	0.75	1.21	2.13	2.68	78%	52%	39%	21%	9%	8%	25%	48%	69%	87%	100%	PROTEUS	SSG	HEALED
29	RAMAN SINGH	50	M	24.32	LT THIGH	6	NO	PAPAYA	0.76	1.21	1.76	2.35	58%	41%	27%	17%	NIL	12%	35%	52%	84%	100%	-	-	-	HEALED
30	SHANTI	46	F	76.16	RT FOOT	9	YES	PAPAYA	0.76	1.78	2.9	3.63	76%	50%	42%	34%	10%	-	18%	41%	74%	82%	100%	E.COLI	-	HEALED
31	SULTHANA	57	F	84.33	RT FOOT	7	YES	N.S.(0.9%)	0.76	1.87	2.46	2.9	54%	39%	28%	14%	NIL	12%	44%	62%	80%	100%	-	-	-	HEALING
32	SUSEELA	52	F	94.89	RT ANKLE	11	YES	PAPAYA	0.77	1.36	2.22	3.76	55%	40%	24%	11%	NIL	11%	34%	59%	78%	100%	-	S.AUREUS	SSG	HEALED
33	ANUSUYA	48	F	98.44	LT FOOT	8	YES	PAPAYA	0.78	1.17	2.42	4.38	62%	41%	29%	10%	NIL	-	22%	54%	81%	100%	-	E.COLI	-	HEALING
34	SOMASUNDARAM	71	M	82.21	RT FOOT	6	YES	N.S.(0.9%)	0.79	1.45	2.32	3.12	62%	46%	37%	28%	14%	11%	30%	41%	54%	72%	92%	-	SSG	HEALED
35	KARUNANIDHI	61	M	120.36	RT THIGH	7	NO	N.S.(0.9%)	0.8	1.77	2.44	3.87	56%	46%	32%	24%	14%	-	24%	40%	71%	88%	100%	E.COLI	-	HEALED
36	REVATHY	45	F	131.46	RT FOOT	10	YES	PAPAYA	0.8	2.72	4.18	7.21	72%	47%	29%	16%	NIL	12%	33%	64%	72%	89%	100%	KLEB	SSG	HEALING
37	AMBROSE	67	M	127.64	LT FOOT	10	YES	N.S.(0.9%)	0.86	1.9	2.52	3.88	60%	44%	32%	20%	12%	10%	31%	47%	61%	77%	94%	S.AUREUS	SSG	HEALED
38	APPA RAO	61	M	112.76	LT FOOT	7	YES	PAPAYA	0.86	2.31	3.75	5.27	68%	43%	30%	12%	NIL	12%	31%	59%	68%	88%	100%	KLEB	SSG	HEALING
39	DURAIRAJ	61	M	106.52	RT LEG	9	YES	PAPAYA	0.86	2.76	3.3	4.92	64%	32%	12%	NIL	-	16%	36%	62%	85%	100%	-	-	-	HEALED
40	NEELAKANDAN	34	M	89.24	RT ELBOW	4	NO	PAPAYA	0.86	3.12	4.85	6.31	62%	36%	12%	NIL	-	-	33%	73%	100%	-	-	-	-	HEALED
41	SATISH	43	M	108.55	RT THIGH	7	YES	N.S.(0.9%)	0.86	2.07	3.44	4.21	49%	36%	27%	18%	8%	10%	28%	41%	59%	77%	100%	KLEB	SSG	HEALED
42	SELVAM	62	M	52.19	LT THIGH	3	YES	PAPAYA	0.9	1.13	1.42	2.6	58%	36%	21%	12%	NIL	8%	42%	78%	91%	100%	-	-	-	HEALING
43	KULANTHAIVELU	62	M	107.54	LT FOOT	9	YES	N.S.(0.9%)	0.91	1.3	1.97	2.76	63%	44%	30%	19%	12%	10%	27%	51%	74%	90%	100%	-	SSG	HEALED
44	DEVADOSS	64	M	127.51	LT LEG	7	YES	PAPAYA	0.92	1.78	3.21	5.16	52%	31%	24%	14%	NIL	-	16%	34%	56%	79%	90%	PSEUDO	SSG	HEALING
45	KOLANCHI	58	F	108.76	RT BACK	9	NO	PAPAYA	0.92	2.45	4.2	6.08	76%	51%	28%	12%	NIL	-	32%	52%	78%	100%	-	S.AUREUS	SSG	HEALED
46	MARIAMMAL	70	F	86.93	RT ANKLE	7	NO	PAPAYA	0.96	2.13	3.6	4.33	66%	47%	33%	20%	NIL	16%	37%	62%	79%	92%	100%	-	SSG	HEALING
47	MAHALAKSHMI	56	F	138.16	RT FOOT	9	YES	PAPAYA	1	1.78	2.65	3.9	67%	49%	31%	19%	11%	10%	32%	54%	72%	91%	100%	-	-	HEALED
48	RAMADOSS	54	M	84.42	LT ARM	7	NO	N.S.(0.9%)	1.04	1.97	2.33	3.12	66%	48%	32%	14%	20%	-	16%	31%	54%	78%	100%	KLEB	SSG	HEALING
49	SAROJA	62	F	116.67	RT FOOT	9	NO	N.S.(0.9%)	1.12	2.82	3.21	4.65	65%	50%	31%	19%	10%	-	19%	37%	60%	78%	100%	-	SSG	HEALED
50	GANDHI	67	M	129.56	RT FOOT	12	YES	PAPAYA	1.17	3.42	5.6	7.14	78%	57%	38%	18%	NIL	6%	34%	52%	76%	92%	100%	-	SSG	HEALED

S.NO	NAME	AGE	SEX	ULCER AREA Sq.cm	SITE	DURATION	DIABETES	DRESSING	REDUCTION IN ULCER SIZE				REDUCTION IN SLOUGH					GRANULATION TISSUE						C/S	ADDITIONAL TREATMENT	FOLLOW-UP 3RD MONTH
									1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	5wk			
51	SENGAI	47	M	155.7	RT FOOT	9	YES	N.S.(0.9%)	1.2	2.66	3.15	4.37	73%	52%	36%	25%	14%	11%	27%	43%	60%	74%	86%	E.COLI	SSG	HEALED
52	KUMARASWAMY	57	M	89.71	RT GLUTEUS	7	NO	PAPAYA	1.22	2.41	3.04	4.47	45%	28%	12%	NIL	-	15%	49%	78%	100%	-	-	-	SEC. SUTURING	HEALING
53	EZHUMALAI	49	M	110.45	RT FOOT	8	NO	PAPAYA	1.28	2.64	3.75	5.38	65%	52%	28%	17%	NIL	14%	38%	62%	80%	100%	-	KLEB	-	HEALING
54	BALAJI	52	M	112.75	LT FOOT	7	YES	PAPAYA	1.3	2.54	3.12	4.68	78%	62%	43%	22%	NIL	8%	21%	47%	63%	91%	100%	E.COLI	-	HEALED
55	LAKSHMI	44	F	130.45	LT FOOT	10	NO	N.S.(0.9%)	1.34	3	4.11	5.28	71%	50%	36%	24%	15%	-	16%	41%	71%	84%	100%	PSEUDO	SSG	HEALED
56	UMAPATHY	60	M	94.47	LT FOOT	10	YES	N.S.(0.9%)	1.43	2.7	3.15	4.88	70%	52%	38%	23%	14%	12%	28%	42%	68%	89%	100%	-	-	HEALED
57	JAMUNA	50	F	146.67	RT ANKLE	9	YES	N.S.(0.9%)	1.44	3.2	5.72	7.21	52%	41%	32%	20%	11%	12%	30%	54%	72%	82%	91%	-	SSG	HEALED
58	MARIAM SULTAN	48	F	94.47	LT FOOT	8	YES	PAPAYA	1.46	2.87	3.75	4.78	58%	42%	31%	20%	NIL	18%	44%	68%	84%	100%	-	-	-	HEALED
59	RANGANATHAN	56	M	123.54	LT FOOT	10	NO	PAPAYA	1.54	3.16	5.27	8.31	77%	51%	32%	20%	NIL	14%	31%	56%	77%	91%	100%	-	SSG	HEALED
60	DEVANDRAN	67	M	131.72	RT ANKLE	9	YES	N.S.(0.9%)	1.73	2.9	4.17	5.11	72%	57%	40%	27%	15%	12%	25%	35%	44%	67%	88%	-	SSG	HEALING
61	RANI	58	F	154.77	LT FOOT	9	YES	N.S.(0.9%)	1.76	3.21	5.66	7.87	60%	42%	31%	26%	20%	18%	30%	52%	64%	78%	94%	PROTEUS	SSG	HEALED
62	RANI	58	F	120.56	RT FOOT	11	YES	N.S.(0.9%)	1.84	2.66	3.44	5.67	44%	34%	30%	22%	14%	13%	36%	51%	62%	88%	100%	E.COLI	SSG	HEALED
63	RANJITHAM	58	F	133.98	ABDOMEN	11	YES	PAPAYA	1.88	3.76	7.32	10.12	82%	54%	36%	12%	NIL	-	24%	41%	62%	89%	100%	PSEUDO	SSG	HEALED
64	CHANDRASEKAR	44	M	244.31	RT LEG	12	NO	N.S.(0.9%)	2.08	4.33	6.24	8.47	78%	59%	41%	21%	NIL	-	22%	51%	77%	100%	-	-	SSG	HEALED
65	SEKAR	62	M	187.22	RT LEG	6	YES	PAPAYA	2.11	4.37	5.13	7.61	72%	44%	31%	17%	NIL	8%	29%	47%	72%	81%	92%	-	SSG	HEALED
66	ANBU	49	M	87.21	RT LEG	12	YES	PAPAYA	-	1.64	2.32	4.77	52%	37%	21%	NIL	-	19%	39%	54%	79%	100%	-	KLEB	-	HEALED
67	ANNAKODI	62	F	74.27	RT LEG	5	NO	N.S.(0.9%)	-	0.89	1.77	2.17	71%	52%	34%	19%	10%	9%	28%	42%	61%	79%	100%	-	-	HEALING
68	ANUSUYA	68	F	69.94	LT FOOT	7	YES	PAPAYA	-	0.87	1.84	2.93	60%	39%	27%	12%	NIL	11%	36%	59%	80%	100%	-	S.AUREUS	-	HEALED
69	ARPUDHAMMAL	42	F	54.23	RT FOOT	6	YES	PAPAYA	-	0.46	1.32	1.89	69%	37%	22%	NIL	-	14%	32%	64%	92%	100%	-	KLEB	-	HEALED
70	BABU	37	M	56.52	RT ELBOW	4	NO	N.S.(0.9%)	-	0.52	0.97	1.27	70%	42%	25%	12%	NIL	-	21%	53%	78%	100%	-	-	-	HEALED
71	BAVANI	57	F	41.22	RT FOOT	6	YES	N.S.(0.9%)	-	-	0.52	0.89	40%	21%	12%	NIL	-	-	20%	38%	65%	84%	100%	-	-	HEALING
72	BAVANI	50	F	61.72	RT HIP	6	YES	N.S.(0.9%)	-	0.62	1.14	1.97	57%	40%	28%	14%	NIL	8%	28%	63%	80%	100%	-	-	-	HEALED
73	BANUMATHY	67	F	111.47	LT FOOT	10	NO	PAPAYA	-	0.75	1.93	3.76	76%	42%	25%	14%	NIL	11%	28%	42%	60%	88%	100%	PSEUDO	SSG	HEALED
74	DHARMARAJAN	56	M	57.66	LT LEG	4	NO	N.S.(0.9%)	-	0.55	0.87	1.27	42%	31%	24%	19%	8%	-	28%	46%	68%	82%	100%	-	-	HEALING
75	ETHIRAJ	67	M	52.76	RT ANKLE	15	YES	PAPAYA	-	0.79	1.08	1.42	32%	21%	8%	NIL	-	15%	51%	76%	92%	100%	-	E.COLI	-	HEALED

S.NO	NAME	AGE	SEX	ULCER AREA Sq.cm	SITE	DURATION	DIABETES	DRESSING	REDUCTION IN ULCER SIZE				REDUCTION IN SLOUGH					GRANULATION TISSUE						C/S	ADDITIONAL TREATMENT	FOLLOW-UP 3RD MONTH
									1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	0wk	1wk	2wk	3wk	4wk	5wk			
76	GOVINDAMMAL	61	F	90.65	RT FOOT	8	NO	N.S.(0.9%)	-	0.75	1.78	2.33	73%	54%	42%	26%	10%	-	19%	37%	60%	88%	100%	-	-	HEALING
77	GANESAN	69	M	75.21	RT FOOT	7	NO	N.S.(0.9%)	-	0.33	0.76	1.25	58%	40%	29%	12%	NIL	16%	47%	69%	82%	100%	-	-	-	HEALING
78	GANESAN	47	M	78.66	ABDOMEN	8	NO	N.S.(0.9%)	-	0.62	1.08	1.47	70%	56%	40%	28%	15%	-	20%	41%	58%	82%	100%	S.AUREUS	SEC. SUTURING	HEALED
79	GUNAVATHY	50	F	31.14	LT LEG	3	NO	PAPAYA	-	0.32	0.84	1.22	78%	32%	12%	NIL	-	-	22%	56%	89%	100%	-	-	-	HEALED
80	JOSEPH	55	M	74.55	RT FOOT	6	YES	N.S.(0.9%)	-	0.82	1.2	1.77	56%	42%	30%	14%	NIL	14%	31%	43%	60%	72%	87%	PROTEUS	SSG	HEALED
81	KAMMNISHA	57	F	78.71	LT FOOT	6	NO	N.S.(0.9%)	-	0.82	1.47	2.92	67%	49%	28%	15%	NIL	10%	27%	44%	69%	90%	100%	-	-	HEALED
82	KONDAIYA	75	M	70.89	LT FOOT	4	YES	PAPAYA	-	0.64	1.33	2.28	64%	50%	42%	21%	NIL	12%	34%	52%	71%	82%	100%	PROTEUS	-	HEALING
83	KOTEESHWARI	44	F	78.84	RT LEG	8	YES	N.S.(0.9%)	-	0.79	1.21	1.87	64%	39%	27%	18%	NIL	-	27%	54%	71%	89%	100%	S.AUREUS	-	HEALED
84	KUMUDHA	44	F	78.96	LT FOOT	7	YES	N.S.(0.9%)	-	0.78	1.22	1.96	60%	42%	38%	18%	NIL	10%	34%	52%	76%	100%	-	KLEB	SSG	HEALED
85	LILLY	63	F	61.71	LT FOOT	8	YES	PAPAYA	-	0.98	1.56	2.12	52%	46%	39%	16%	NIL	16%	48%	62%	81%	100%	-	PROTEUS	-	HEALED
86	MALLIGA	48	F	78.75	RT LEG	6	NO	N.S.(0.9%)	-	0.76	1.12	1.75	62%	47%	31%	19%	NIL	-	21%	55%	76%	100%	-	-	-	HEALED
87	MEENATCHI	72	F	47.21	RT HIP	6	NO	PAPAYA	-	0.66	0.95	1.43	76%	42%	18%	NIL	-	10%	47%	76%	100%	-	-	-	SEC. SUTURING	HEALING
88	MOHAMMED IMAM	45	M	54.64	ABDOMEN	9	NO	N.S.(0.9%)	-	0.46	0.92	1.2	52%	54%	30%	12%	NIL	20%	39%	55%	78%	100%	-	E.COLI	SEC. SUTURING	HEALED
89	NIRMALA	39	F	66.72	LT FOOT	7	YES	N.S.(0.9%)	-	0.56	1	1.28	64%	40%	28%	14%	NIL	-	14%	30%	52%	79%	100%	-	-	HEALED
90	PADMAVATHI	47	F	80.11	RT FOOT	5	NO	PAPAYA	-	0.72	1.32	2.07	60%	32%	20%	NIL	-	10%	33%	75%	100%	-	-	-	-	HEALED
91	POONGAVANAM	60	F	61.21	LT FOOT	5	NO	PAPAYA	-	0.83	1.1	1.75	70%	54%	22%	NIL	-	12%	48%	76%	100%	-	-	E.COLI	-	HEALED
92	PUNITHAVATHY	59	F	62.05	LT ANKLE	8	NO	PAPAYA	-	0.92	1.43	2.21	61%	42%	28%	NIL	-	8%	32%	58%	79%	90%	100%	-	SSG	HEALED
93	RAMA KANTH	49	M	60.04	ABDOMEN	10	NO	N.S.(0.9%)	-	0.63	1.08	1.47	52%	41%	28%	14%	NIL	19%	32%	60%	76%	91%	100%	-	SEC. SUTURING	HEALED
94	ROSE	55	F	62.54	ABDOMEN	9	NO	N.S.(0.9%)	-	0.8	1.17	1.5	40%	28%	21%	12%	NIL	14%	38%	52%	77%	100%	-	-	SEC. SUTURING	HEALED
95	SELVARAJ	56	M	56.6	SCROTUM	5	NO	N.S.(0.9%)	-	0.5	0.92	1.21	65%	42%	25%	10%	NIL	-	12%	38%	52%	76%	100%	KLEB	SEC. SUTURING	HEALED
96	SHANTHI	49	F	17.05	RT FOOT	10	YES	PAPAYA	-	-	0.5	0.86	54%	26%	10%	NIL	-	19%	57%	79%	100%	-	-	KLEB	-	HEALED
97	SUJATHA	48	F	96.73	RT FOOT	6	YES	N.S.(0.9%)	-	0.89	2.17	3	68%	51%	36%	28%	14%	12%	28%	46%	71%	90%	100%	E.COLI	SSG	HEALED
98	UMAPATHY	62	M	64.66	LT LEG	12	YES	PAPAYA	-	0.4	0.78	1.88	54%	41%	28%	20%	NIL	14%	36%	58%	80%	100%	-	-	-	HEALING
99	VALLI	80	F	21.78	LT FOOT	7	YES	PAPAYA	-	0.76	1.32	1.89	76%	51%	36%	12%	NIL	6%	38%	69%	86%	100%	-	-	-	HEALED
100	VARADHARAJAN	62	M	60.16	RT FOOT	7	YES	PAPAYA	-	0.75	1.18	1.38	72%	51%	32%	11%	NIL	8%	21%	39%	59%	82%	100%	S.AUREUS	SSG	HEALED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